# An Economic Evaluation of Producing HY320 Wheat on the Prairies

Department of Agricultural Economics
University of Saskatchewan, 1984

# AN ECONOMIC EVALUATION OF PRODUCING HY 320 WHEAT ON THE PRAIRIES

by

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The authors wish to acknowledge the financial support given to them by the Saskatchewan Department of Agriculture to carry out this study.

October, 1984

## PREFACE

In the past, Canada has produced and exported primarily high quality wheat used in the production of milling and baking products. To maintain the maximum benefits from both domestic and export markets of this high quality and premium priced wheat, Canada developed a comprehensive grading and licensing system. The Canadian Grain Commission was set up with statutory authority to implement, supervise and regulate the Canadian grading system. The Canadian Seeds Act was set up, also with statutory authority, as a way insuring that only those varieties exhibiting merit would be sold in Canada.

Since their inception, almost 60 years ago, the Canadian Grain Commission and the Canadian Seeds Act have interacted to provide the present basis for Canada's present licensing system for cereals; a variety must have agronomic merit, acceptable quality and fit into the grain grading system. Under the present system, groups of scientists and selected industry personnel (i.e. the Expert Committees on Grain Breeding, Diseases and Quality) meet once a year to recommend which newly developed varieties or foreign introductions should be licensed. These recommendations, along with data to back up the recommendations, are given to the Variety Evaluation and Licensing Section of the Seed Division of Agriculture Canada and are then usually, but not always, added to the Seeds Variety Order as set out in the Canadian Seeds Act (i.e. the variety is licensed).

Crop scientists generally make most of the recommendations regarding a variety's agronomic merit. Recommendations regarding a variety's quality and ability to fit into the present grading system are generally made by a combination of cereal chemists, industry

personnel and members of the Canadian Grain Commission.

The combination of an elaborate and strict grading and licensing system have certainly done a great deal to build and maintain Canada's reputation as a large supplier of consistently high quality, premium priced, hard blending wheat. However, since the 1960's the export market for hard blending wheats has not grown nearly as quickly as the export markets for medium-hard and soft wheats. Canada, because of its great emphasis on the production of hard blending wheat, has not been able to supply, in any significant manner, the great growth in demand for medium-hard and soft wheats.

Since 1974, a new semi-hard wheat variety called HY320 has been tested for agronomic merit by plant scientists across the Prairies. This variety, although exhibiting some disease susceptibility, has produced yields that are, on the average, 30 percent higher than traditional Canadian hard wheats. However, this variety has yet to be licensed in Canada. Should it be and/or should the present wheat licensing and grading system be changed to accommodate it and/or other wheat varieties like it?

The issue revolves around whether the present emphasis on the production of high quality blending wheat should be continued in light of an increasing world demand for wheat of somewhat lower quality. Proponents of continued emphasis on high quality blending wheat point to the relatively stable demand for high protein red spring wheat in Japan, Western Europe and the Soviet Union where such wheat commands a significant price premium. They argue that countries that are unwilling and/or unable to pay a price premium for Canada's best blending wheats can still purchase our lower grades of wheat or even

our high grades of wheat that are in excess of the needs of the premium priced markets.

Proponents of large scale production of several classes of wheat on the Prairies draw attention to the diverse climate and soil conditions that exist within the Prairies. If these diverse conditions are to be fully exploited, production of a wide range of varieties and classes must be allowed. Furthermore, the growth markets for wheat in the 1980's could be largely accommodated by wheats of the HY320 type.

Canadian policy makers, farmers and industry personnel are increasingly arguing the merits of both sides of this issue (i.e. which "quality" of wheat should be produced to maximize the net returns of producers). The Saskatchewan Department of Agriculture is obviously concerned with any chance that might affect the Canadian wheat sector. Because of this concern, they asked the authors to look at some of the economic consequences of licensing or not licensing HY320-type wheats.

## EXECUTIVE SUMMARY

In the past, Canada has produced and exported primarily high quality wheat used in production of milling and baking products. To maintain the maximum benefits from both domestic and export markets of this high quality and premium priced wheat, Canada developed a comprehensive grading and licensing system whose chief elements are the Canadian Grain Commission and Canadian Seeds Act. The combination of an elaborate and strict grading and licensing system have certainly done a great deal to build and maintain Canada's reputation as a large supplier of consistently high quality, premium priced, hard blending wheat.

However, since the 1960's, the export market for hard blending wheats has not grown nearly as quickly as the export markets for medium-hard and soft wheats. Canada, because of great emphasis on the production of hard blending wheat, has not been able to supply, in any significant manner, the great growth in demand for medium-hard or soft wheats.

Canadian policy makers, farmers and industry personnel are increasingly arguing over whether the Canadian grading and licensing system's emphasis on the almost exclusive production of high quality, hard blending wheats is likely to continue to maximize the net returns of producers. This issue is becoming increasingly controversial because: 1) in the 1970's and 1980's the fastest growing export wheat markets have been for medium-hard and soft wheats, 2) certain areas of the Prairies have difficulty producing top quality hard blending wheats,3) an agronomically suited, medium-hard wheat variety called HY320 has been developed. It has been tested agronomically since 1974

and yields, on the average, 30 percent more than traditional hard spring wheat varieties, however, this variety has yet to be licensed.

Because of the mounting concern over this issue, the authors attempted to look at some of the economic consequences of licensing or not licensing HY320-type wheats. To do this, the authors took the approach that the classes of wheat that should be produced (and, therefore, licensed) should be determined on the basis of which classes of wheat are most likely to maximize the net return received by the producer from growing spring wheat (excluding durum and soft wheat).

To answer this question the Prairie region was broken down into crop districts. The historic annual farmgate wheat sales for the eleven crop-years between 1972 and 1982 were calculated for each of these districts by using crop district level data on the annual grading pattern, prices for each grade, production, freight rates and handling charges. Next, conservative assumptions were made regarding the likely yield increase, grading patterns and pricing levels that would have resulted had HY320 been licensed and grown. To be even more conservative, it was assumed that all the extra production due to HY320's higher yielding ability would have to be shipped at the full compensatory (i.e. Non-Crow) freight rate. These numbers were then used to calculate what annual farmgate wheat sales would have been, had HY320 been licensed and widely grown. Several possible pricing regimes for HY320 were tried in order to test the sensitivity of the results to possible changes in relative price levels between hard and medium-hard wheats.

Very briefly, the results of this study showed that farmers in the

black soil zone have much greater financial incentive to switch from growing hard wheat to growing HY320-type wheats, than do farmers in the brown soil zone. This is particularly so in areas of the black soil zone where grades of hard wheat are traditionally low. Given even quite extreme price scenarios, some areas of the black soil zone would have no incentive to switch back to hard wheat once HY320-type wheats were licensed.

Total farmgate wheat sales (not including durum or soft wheat) would likely be at least 5 to 10 percent higher if HY320-type of wheat were licensed. Such a sales increase would be associated with an increase of 15 to 30 percent in volume of wheat produced and in handling charges paid to grain companies. If this incremental volume was hauled to export positions under compensatory freight rates, the cost of freight would rise 50 to 100 percent.

Since additional freight, handling and additional necessary farm production costs were subtracted before the total farmgate sales comparisons were made, the foregone farmgate sales figure actually represents foregone net farm income. It was estimated that the present cost to Canada of not licensing HY320-type wheat is of at least the same magnitude as the 1982 realized net farm income from farming of all farmers in Manitoba, (i.e. $200 to $400 million dollars).

There are several compelling reasons to believe that this estimated cost is, on the average, indeed a minimum one. However, there is a small chance that this cost would be greatly exaggerated if the licensing of HY320 led to a price war among the major wheat exporters. Such an occurrence is possible but rather unlikely.

TABLE OF CONTENTS


| Chapter | Page |
|---|---|
| PREFACE | i |
| EXECUTIVE SUMMARY | iv |
| TABLE OF CONTENTS | vii |
| LIST OF TABLES | viii |
| LIST OF FIGURES | ix |
| I. INTRODUCTION | 1 |
| II. AN OVERVIEW OF THE DEMAND FOR VARIOUS CLASSES OF WHEAT | 3 |
| III. THE WHEAT EXPORTERS | 14 |
| IV. PRICING CANADA'S MEDIUM-HARD WHEAT | 25 |
| V. ESTIMATING THE BENEFITS, IF ANY, FROM LICENSING HY320-TYPE WHEATS | 33 |
| 5.1 Comparing Farmgate Sales | 34 |
| 5.2 Grading Patterns | 36 |
| 5.3 Prices | 38 |
| 5.4 Yields | 44 |
| 5.5 Extra Farm Costs | 45 |
| 5.6 Handling Costs | 49 |
| 5.7 Extra Transport Cost to Ports | 50 |
| 5.8 The Results under Several Scenarios | 54 |
| VI. THE COST OF NOT LICENSING HY320-TYPE WHEATS | 62 |
| VII. SUMMARY AND CONCLUSIONS | 66 |
| VIII. REFERENCES | 69 |
| IX. APPENDIX | 71 |

## LIST OF TABLES


Page

1. Some Major Characteristics of the Three Largest Classes of Wheat..... 6
2. Major Wheat Trade Flows..... 15
3. Import Markets Where the Majority of Wheat Imports are Supplied by One Exporter..... 15
4. The Historic Grading Pattern of Wheat in Alberta C.D. #7 (72/73-81/82)..... 37
5. The Tentative Grading Pattern of HY320 if it had been Grown in Alberta C.D. #7 (72/73-81/82)..... 40
6. Some Yield Trials Comparing HY320 with Neepawa..... 45
7. The Variable Costs Associated with a Higher Yielding Variety of Wheat (81/82)..... 47
8. Annual Total Variable Costs Associated with a Higher Yielding Variety of Wheat (72/73-82/83)..... 50
9. Primary Elevator Handling Charges..... 51
10. Grain Freight Rates of Selected Points Compared to the Freight Rate for Scott, Saskatchewan..... 53
11. Approximate Annual Non-subsidized Freight Rate for Wheat from Scott, Saskatchewan to Thunder Bay/Vancouver..... 55
12. The Percent Change in Farmgate wheat Sales if HY320 had been Grown Instead of CWRS (total effects after 11 years)..... 57
13. Approximate Minimum Foregone Farmgate Wheat Sales in 1982/83. 65

## LIST OF FIGURES

Page

1. The Relation of Total Revenue to Elasticity of Demand..... 26
2. Comparison of CWRS Grades and Tentative HY Grades..... 39
3. Comparison of CWRS Prices and Tentative HY Prices..... 43
4. The Effect on Total Farmgate Wheat Sales..... 61

# CHAPTER I

## INTRODUCTION

Ever since the European settlement of the Prairies, Canada has had a world-wide reputation for producing some of the best quality hard wheat in the world. This reputation includes both the reputation for consistency within grades, tightness of grade specifications and the reputation for wheat that produces an ideal type of leavened bread loaf. To this day, this reputation has been maintained and #1 Canadian Western Red Spring (CWRS) wheat is still the most expensive export wheat in the world.

However, the world wheat market has been changing gradually with relatively lessened import demand for hard wheats and relatively increased demand for medium-hard and soft wheats. Some would say Canada has not kept up with the times because we still do not grow or export an appreciable amount of medium-hard wheat. Others say Canada has been justified in being very cautious and conservative when our reputation for being the exporter of the best wheat in the world is at stake.

Presently, many Prairie farmers are expanding their acreage of medium-hard semi-dwarf wheats, particularly in Manitoba. Until now no wheat of this type has been licensed. In the last two years the Canadian Wheat Board has instituted a contract program with farmers to grow a strain of medium-hard semi-dwarf wheat called HY320. The Canadian Wheat Board and the Canadian Grain Commission are using the production from these HY320 contracts to test market it in countries that traditionally consume medium-hard wheat from the USA and

Australia and lower grades of hard wheat from Canada.

If HY320 proves comparable to American or Australian medium-hard wheats in overseas markets it will probably be licensed. Wheat breeders in Canada are already stressing that it is very possible to produce medium-hard wheats that are agronomically superior to HY320. It is very likely that these potential new varieties, when released and licensed, would quickly replace HY320. Unfortunately, data on the new, improved medium-hard wheats is not available. Suffice to assume that they would be agronomically superior to HY320 (i.e. higher yielding, more disease resistant). Thus, calculations using the relatively plentiful data on HY320 should represent the lower limits of the advantages that may be obtained from growing more medium-hard wheats in Canada.

This study attempts to do three things. First, it tries to conservatively estimate where and to what extent HY320 will likely be planted, should it be licensed. Second, it attempts to estimate the change in total farmgate wheat sales that might be expected if HY320 were licensed. Third, it tries to roughly estimate the annual net farm income Canada may be giving up for each year it does not allow some hard wheat acreage to shift into the production of medium-hard wheat.

## CHAPTER II

## AN OVERVIEW OF THE DEMAND FOR VARIOUS CLASSES OF WHEAT

Wheat, has for millineums been considered the "staff of life" by many peoples around the world. The wheat plant in its various genetic forms is highly adaptable to a wide variety of growing conditions. It is for this reason that wheat has been grown by peoples in widely differing regions of the world. Each of these regions has, in turn, developed certain methods to treat and prepare the wheat kernels into a form suitable for human consumption. These processes have ranged from the rather basic preparation of bulgar wheat in the Middle East to the complicated process of preparing yeast-leavened breads in Europe.

In addition, wheat has been used increasingly around the world as a food-stuff for animals. In fact, the livestock feed market is presently one of the more important growth markets for wheat. This market has developed because of the combined effects of increased demand for meat products as incomes rise coupled with improvements in wheat feeding technology.

Generally speaking, each type of wheat grows best in a particular agro-climatic region. For instance, wheat types with soft kernels generally do best in relatively moist, warm areas with a long growing season; wheat types with very hard kernels generally do best in relatively dry areas with a short growing season and cool nights. Such phenomena have had a significant influence on the way wheat is consumed in particular regions. For instance, China for centuries has experienced a shortage of cooking fuel in its most populated regions.

This led, in part, to the wide use of fuel conserving cooking methods such as stir-frying and the use of steamers instead of baking ovens. Much of the populated areas in China suitable for wheat growing are relatively warm and moist. The type of wheat that did best in these growing conditions was a semi-hard wheat. Because the steaming of bread does not produce a crust, steamed bread prepared from red bran wheat flour made with simple milling equipment often produced undesirable dark flecks in the surface of the steamed bread. This led to the almost exclusive use of white skinned wheats for steamed bread products. In addition, the medium-hard wheats that did so well agronomically contained medium levels of protein. If steamed bread is prepared with flour containing very high or very low levels of protein, an undesirable shape and texture of steamed bread is produced, particularly when traditional flour and dough preparation techniques are used.

In Europe, the use of soft wheat flour to make French style breads is a further example of this phenomena. Much of the French wheat crop is grown in warm, moist areas with a relatively long growing season. These type of conditions are most suited to the production of soft wheats. The French, in turn, use mostly soft wheat flours in their bread and bakery products.

These are but two examples of how the type of wheat that was agronomically best suited to an agronomic region had a great deal of influence on the type of wheat products that were eaten in that region. Generally people have a strong preference for eating wheat in the form that was historically most suited to the type of wheat that did best in their particular agronomic regions.

Wheat kernels vary widely in physical characteristics (e.g. Wheat can be hard, medium or soft in texture; it can have a white or red skin color). The percentages of protein, minerals, vitamins, pigments and enzymes show a relatively wide range between and even within classes of wheat. These differences have very significant effects on the processing, use, nutritive value and economic value to consumers. Milling and processing techniques further widen the range of composition and physical properties of flours and by-products (e.g. using an air separation apparatus, white flour can readily be prepared with any level of protein desired from less than 2 percent to more than 25 percent from a single wheat of 12 percent protein).

Wheat can be classified in many different ways depending on the ultimate objectives of the classifier (for example, a geneticist may classify according to the number of chromosomes, a trade statistician may classify according to country of origin). This study is concerned with major end uses of wheat for human consumption and hence will put wheats into one of the following classes: 1) hard, 2) medium-hard, 3) soft, and 4) durum. Durum wheat is generally considered to be a quite distinct product from any of the first three classes by people in the wheat trade.[1] For this reason it will not be included in the description and analysis that follows. The first three classes are briefly described in Table 1.

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[1] This is not to say that durum cannot be substituted for other types of wheat should the economic incentive exist for such substitution. Historically, the price of Canadian durum wheat has been almost always within 10 percent of the price of Canadian hard wheats.

Table 1: Some Major Charactistics of the Three Largest Classes of Wheat

| Class | % Protein | Kernel Hardness | Gluten Strength | Major Exporters' Main Traded Grades | Major Uses | Major Importers |
|---|---|---|---|---|---|---|
| Hard | 11.5-14.0 | Hard | Strong | Can.-CWRS USA-DNS, some HRW Argentina-Trigo Pan Australia-Prime Hard and Hard | loaf breads pan de sal pan de agua | USSR, China, Brazil, Japan, U.K.,Cuba Nether-lands |
| Medium | 10.0-12.0 | Medium | Medium | USA-white, most HRW Australia-most ASW | French breads, steamed bread, noodles, chapaties, Arab breads | USSR, China Brazil, Japan, Iraq, Iran, Egypt, Israel |
| Soft | 8.0-9.0 | Soft | Weak | France-by lot specification USA-White USA-SRW | French breads, pasteries, confection-aries | USSR, China, Brazil Japan |

Note: CWRS = Canadian Western Red Spring
DNS = Dark Northern Spring
HRW = Hard Red Winter
ASW = Australian Standard White
SRW = Soft Red Winter

## The Blurring of Boundaries Between Wheat Classes

Traditionally, certain classes of wheat were used especially to make certain types of products because the composition of that particular class of wheat was most likely to produce the highest level of desirable characteristics in the finished product at minimum cost (e.g. medium wheat was used to produce steamed products). However, technical advances in the milling and baking industries have blurred

any sharp distinctions that may have existed between the use of a particular type of wheat for a particular type of product (e.g. the Chorleywood process allows more soft wheat to be used in the production of a type of bread that traditionally required a large percentage of hard wheat).

It is becoming more and more technically feasible to make any type of wheat-based product from any class of wheat. In the extreme such products as foam cake mixes, traditionally produced from soft white wheat, could be produced from dark durum wheat and spaghetti, traditionally produced from amber durum wheat, could be produced from soft white wheat. Such physical substitution possibilities are almost never exploited because they are not economically profitable. However, such things as government regulations, wars, port closures, government subsidies and technological discoveries have, at times, dramatically changed the economic incentives to substitute different classes of wheat for different end products. The following scenario will hopefully illustrate the increasingly fuzzy nature of the deliniation of wheat classes on the basis of major end use.

In Egypt a large portion of total wheat consumption is in the form of unleavened bread made traditionally with a medium protein wheat having a white skin. Suppose a drought strikes and the Egyptians find they must import wheat for a one month period between the time their wheat stocks are depleted and their new wheat crop can be harvested. In that particular time period only three countries have wheat to sell. The USA has available large quantities of hard red winter wheat, the EEC has large quantities of soft white wheat, and Canada has available lower grades of hard red spring wheat. The Egyptians

have just had a political falling out with the USA and have, therefore, declined, on political grounds, to buy any grain from the USA even though it is the most physically similar to the wheat they traditionally use and offered on concessional terms.

Their use of the EEC wheat would require either: 1) air separation of the largest flour particles containing the lowest protein - hence raising the average protein of the remaining flour when the large flour particles are removed, 2) additional purchases of small quantities of high quality wheat so a blend of both high and low imported wheats produce a medium protein flour, 3) producing a lower quality Egyptian bread for one month.

Their use of the Canadian lower grades of wheat would require either: 1) air separation and removal of the smallest flour particles containing the highest protein hence lowering the average protein of the remaining flour plus milling to a finer tolerance so that red bran particles do not appear in the flour, 2) purchases of additional quantities of low quality wheat so a blend of both high and low imported wheats produced a medium protein flour, 3) producing a lower quality Egyptian bread for one month.

In this situation what the Egyptians actually do depends on a variety of factors. Do they have the high grade milling facilities necessary to handle the Candian wheat? Is the EEC willing to offer a cut-rate price just to get rid of undesirable EEC stocks? Will Egyptian consumers accept a poorer quality bread for a month? Which importer has the most Egyptian "good-will"? Which source can guarantee delivery in the month specified? Which source will offer an extension of credit or subsidized interest rates? Answers to these

type of questions would determine to a major extent the amount of each wheat that is purchased.

Theoretically the demand for a particular class of wheat could be defined as:

$$D = f\ (\overset{+}{\text{own price}},\ \overset{-}{\text{price of other classes of wheat}},\ \overset{+}{\text{milling and baking technology}},\ \overset{+ \text{ or } -}{\text{existing transport and storage conditions}},\ \overset{+ \text{ or } -}{\text{domestic and foreign government policies}},\ \overset{+ \text{ or } -}{\text{incomes}})$$

The effect of prices on the demand for a particular class of wheat is probably the most straightforward. Ceteris paribus, as the price of a class of wheat rises the quantity demanded of that class of wheat will decline and, secondly, as the price of other classes of wheat rise, the demand for the class of wheat in question will rise as consumers begin to buy more of the relatively cheaper priced class of wheat.

The theoretical effect that the other factors have on the demand for a class of wheat is indeterminate. For instance, the demand for a particular class of wheat will increase if new milling and baking technology allows the economical substitution of that particular class of wheat for the traditional uses of other classes (e.g. the Chorleywood Bread Process allows the technical substitution of more soft wheat in the production of bread traditionally made with hard wheat).

Similarly, the effect that government policy has on the demand for a particular class of wheat is indeterminate. For example, the government in a soft wheat producing country may increase the tariff on the import of hard wheat. This may raise the cost of hard wheat to

millers to the extent that it pays them to buy improved aeration equipment so they can better separate the high quality protein fractions from their soft wheat flours and hence produce the same quality of bread as before even though it now costs them more to do so. (Assuming, of course, that such alternatives result in cheaper bread than if they import the high quality wheat and pay the tariff). In this case government policy has decreased the demand for hard wheat. Government policy may have had the opposite effect if, for instance, the government decided they must utilize a flour mill that could only handle hard wheat.

A further complication arises from the fact that millers usually use a blend of flours for a particular purpose. The exact blend is usually, but not always, the combination of wheats that will give a flour with certain minimum quality characteristics (e.g. a minimum protein level) at lowest unit cost. However, physical constraints, buyer ignorance and "good-will" may at times restrict a flour miller's ability to produce the theoretically cheapest blend of flour.

Given relatively unrestricted markets and grain movement, high protein flour will be made only from hard wheat and low protein flour will be made only from soft wheat. However, medium protein flour can be made easily from either medium-hard wheat or from a blend of hard and soft wheats. These physical substitution possibilities make it even harder to clearly differentiate the demand for a particular class of wheat and more especially, the medium-hard class of wheat.

To make matters even more complicated, complimentarity between classes of wheat may at times reverse the expected price/quantity effects. For instance, an extra large crop of domestic soft wheat in

the EEC may actually increase the demand for hard wheat exports from Canada or the USA. Initially, one might expect that since total wheat production has increased all wheat prices will fall. However, what may happen, instead, is that the price spread between hard and soft wheat widens.

For example, consider the case of many countries in the Middle East. In years of high domestic production, the EEC exports soft wheat that is in excess of its needs. Often the EEC soft export wheat is sold at a significant price discount[2] to American or Australian soft wheat to minimize the amount of wheat stocks the EEC has to carry over. If the price discount is significant enough, traditional importers of medium-hard wheat (e.g. Middle East countries) may switch to buying the cheap EEC soft wheat and some very hard wheat (e.g. CWRS or US-DNS) wheat to blend together to produce a flour comparable to the flour from the medium-hard wheat they customarily import from Australia. In a situation such as this, it is clear that the relatively low prices of soft wheat from the EEC could lead to increased demand for both soft wheat from the EEC and hard wheat from the USA at the expense of lessened demand for medium-hard wheat from Australia.

Similarly, a country such as China, that imports all classes of wheat and also produces domestically large quantities of soft wheat may find it advantageous to import more hard blending wheat and less medium-hard wheat in years when domestic soft wheat production is

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[2] At times, instead of straight-forward price cuts the EEC has been known to use subsidized interest rates or an extension of a line of credit.

relatively high. Such a policy will insure that all the domestic soft wheat production is used domestically.[3]

In addition, countries may repeatedly import one class of wheat over another class of wheat because of foreign exchange and/or political considerations in spite of the fact that their end-uses for wheat imply they should be importing a different class of wheat. Consider, for instance, those countries that traditionally receive food aid from the Canadian International Development Agency (CIDA). The major end-uses of wheat in most of these food aid recipient countries imply that they would prefer to import medium-hard wheat. On the other hand, CIDA buys all its wheat from within Canada and hence has mostly hard wheats to give as food aid.

Furthermore, trade statistics from the wheat exporters may, at times, be also misleading when trying to estimate the demand for a particular class of wheat. It is not uncommon to find a considerable overlap between characteristics of one grade and another grade and even between one class and another class from the same exporting nations. Statisticians like to draw sharp lines between what falls into one class and what falls into another class. Such sharp distinctions are necessary for many statistical purposes but may, at times, lead to misleading conclusions because of the sharp divisions

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[3] This factor must certainly be kept in mind when looking at the Chinese market. In the 1970's, the Chinese purchased mainly #3 CWRS wheat from Canada. However, since 1980 the Chinese have purchased mainly #1 and #2 CWRS wheat from Canada. Is this switch because: 1) the Chinese have switched to more domestic soft wheat production and hence, now require the higher protein of #1 and #2 for blending or (2) is it simply because their foreign exchange is not as restricted as it was in the 1970's or (3) is it for an entirely different reason?

that are often used.

For instance, in the USA it would not be unusual for over 30 percent of the Hard Red Winter (i.e. HRW) wheat crop to grade above 12 percent protein. Hard Red winter wheat is normally considered a medium-hard wheat but it can compete quite directly in markets dominated by American-Dark Northern Spring Wheat (i.e. DNS) and Canadian CWRS wheat when the protein content is above 12 percent. Conversely, the lower protein portion of the DNS crop may compete more directly in the medium-hard wheat markets than in the hard wheat markets. Trade statistics that put HRW entirely in the class of medium-hard wheats could thus bias the estimated demand for medium-hard wheat upward. Conversely, if all the DNS were put in the hard wheat class it could bias upward the estimated growth in demand for hard wheats. Hopefully, in this case, the lower protein DNS exports approximately balance the higher protein HRW exports and no great biases are introduced, but this is not always the case.

In summary, there are no nice and easy ways to calculate changes in the demand for various classes of wheat because the boundary between each class is becoming increasingly blurred. Any econometric study that looks at only published quantities and prices may produce misleading estimates of the demand for various classes of wheat because so many nonprice factors enter into the final decision to purchase a particular class of wheat from a given supplier in a particular year. To be meaningful, such statistics must be combined with a great deal of nonstatistical information before reliable estimates for the demand for different classes of wheat can be made.

# CHAPTER III

## THE WHEAT EXPORTERS

In the last forty years the world wheat export market has experienced quite significant structural changes. A major exporter has become a major importer. Trade flows have been altered and price leaders have become price followers. Tables 2 and 3 presents a brief summary of the major wheat trade flows that presently exist. Oleson [1979] developed a description of the changes that have taken place among the traditional major exporters of wheat. Until the 1960's the major world wheat exporters were Canada, the USA, Australia, Argentina, France and the USSR. After this period, the USSR rapidly switched from being a major exporter to being one of the world's major importers of wheat. This turn-around was largely a result of the USSR's decision to greatly increase meat production by using increased amounts of cereals as animal feed. Because wheat is grown on over 30 percent of all cultivated land in the country and the area planted to wheat is almost twice as large as the wheat area of any of the next three biggest wheat producers (i.e. USA, China, India) this decision on the part of USSR has had dramatic repercussions on the world wheat market (e.g. a 10 percent drop in planned USSR production is almost equivalent to Canada's total wheat exports).

Until the mid 60's Canada was the world's major wheat exporter and most of the world trade in wheat consisted of hard wheats. Although countries like the USSR and the USA produced more wheat than Canada their large domestic markets left them with usually less exportable surpluses. In addition, government policy in the USA encouraged

Table 2: Major Wheat Trade Flows

| Exporter | Largest Regional Importers | | | | |
|---|---|---|---|---|---|
| | Europe | USSR | C. and S. America | Asia | Africa |
| Argentina | - | USSR | Brazil, Peru | - | - |
| Australia | | USSR | - | China, Japan, Iraq, Iran | Egypt |
| Canada | U.K.,Italy | USSR | Cuba, Brazil Chile, Venezuela | China, Japan, Saudi Arabia, Iraq | Algeria, Morocco |
| EEC | | USSR | - | - | Egypt, Nigeria |
| USA | Netherlands, Poland, Italy Yugoslavia | USSR | Mexico, Brazil | Japan, China S. Korea, Philippines | Egypt, Nigeria |

Table 3: Import Markets where the Majority of Wheat Imports are Supplied by One Exporter

| Exporter | Import Markets Dominated |
|---|---|
| Argentina | Uruguay, Paraguay |
| Australia | Middle East except Saudi Arabia, Asia except China, Japan |
| Canada | UK, Cuba |
| EEC | All Africa except Nigeria, Egypt, Sudan and countries on Mediterranean |
| USA | Netherlands, Portugal, Spain, Yugoslavia, Czechoslovakia, Romania, Bangladesh, S. Korea, Philippines, Taiwan, Nigeria, Sudan, Tunesia, Zaire, all C. and S. America except Cuba and Brazil. |

acreage set-asides that deliberately allowed Canada to maintain a price leadership role among world exporters. (Even the International Wheat Agreement of the time used only the price of Canadian No. 1 Manitoba Northern basis Port William/Fort Arthur as the standard world price of wheat).

McCalla [1966] described the basic market structure of this time as a duopoly[4] with fringe participants. The fringe participants consisted of Australia, France, Argentina and the USSR with the major participants being the USA and Canada. The USA willingly let Canada play the price leadershp role. Under McCalla's duopoly model, the fringe participants sold all their crop every year at the price established and agreed upon by the major participants. The major participants maintained prices by deliberately building up or releasing stock.

However, several events brought an end to this traditional arrangement. First of all, the USSR and China began greatly increasing their imports of wheat. Because of American political leanings, almost all of these increased purchases were made from Canada, Australia and Argentina. The Americans felt that under these circumstances they should be allowed a larger market share of the more traditional wheat import market since the Americans had, by their large stocks holding policy, enabled Canada and other wheat exporters

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[4] The term duopoly, triopoly and oligopoly are used rather loosely in this chapter following the terminology used in the cited references. In this context they imply that between two and five exporters supplied almost all the exported wheat in the world; they do not imply that these exporters had market power vis-a-vis wheat importing nations.

to maintain stable wheat prices and market shares in the more traditional wheat markets. When no agreements on new market sharing arrangements were forthcoming, the Americans began releasing their stocks and cutting prices. This action was repeatedly carried out in the late 60's. It resulted in three international price wars and wide swings in the volume and direction of trade. It also led to the emergence of the USA as the most dominant wheat exporter in the world.

In addition to the expanded Chinese and Soviet purchases the world wheat market was further upset by the emergence of Australia as a very significant wheat exporter. As Australian production increased the Americans and Canadians were less and less willing to allow it to act as a fringe participant. As Australia cut prices to move their current year's production the Americans and Canadians countered with price cuts of their own. This further accentuated the world wheat price wars of the late 60's. Finally, in 1969 the Australians were forced into a storage program, smaller in size, but similar in scope, to the storage programs of the Americans and Canadians.

By 1972 a more stable triopoly involving the USA, Canada and Australia had emerged. Alaouze, Watson and Sturgess [1978] followed up the previously mentioned work of McCalla and described the nature of this transformation from a duopoly to a triopoly using the hindsight afforded them by working in the late 1970's.

The triopoly that evolved had the USA, Canada and Australia as the major holders of stocks and consequently, as the major market powers. Because American stocks were by far the largest, the USA price became, in fact, the prime reference price. By 1972 the market shares of these three exporters was vastly different from that of the previous

five years.

However, the large carryover stocks of these oligopolists was rapidly depleted in a couple of years following 1972. This was caused by the dramatic increase in wheat demand due to crop failures in some Asian countries coupled with the USSR decision to expand grain-fed livestock production. As carryover stocks were depleted the three major wheat exporters found their market power to stabilize prices greatly lessened.[5]

By the end of the 1970's, world wheat production was again growing at a faster rate than world wheat consumption. The three major wheat exporters, and particularly the USA, were once again forced to build up stocks. In addition, the EEC rapidly emerged as a new wheat exporter with the financial might and willingness to become more than self-sufficient in wheat production. Will the EEC be eventually forced to hold stocks and join the wheat oligopoly just as Australia was forced in the late 1960's? It seems inevitable that one of the three scenarios must take place in the next few years: 1) the major exporters will have to hold stocks to maintain price at the point of unitary elasticity on the residual demand curve facing them, 2) major exporters will engage in price wars with competing exporters until a new market-share equilibrium is reached among market participants (i.e. the EEC is forced to hold stocks), 3) demand increases dramatically, hence postponing the possibility of scenario (1) or (2).

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[5] Documentation of the above described changes in price and stock-holding behavior can be found in McCalla [1966], Oleson [1979] and Alouze, Watson and Sturgess [1979].

Whether or not the new market share equilibrium is similar to the previous cycle's equilibrium depends on whether relevant technical variables and government policies have changed in major wheat exporting and importing countries (e.g. Australia's continued expansion of its wheat production capacity eventually led to a new market share equilibrium as did the American government decision to enter into sales with communist nations).

What relevance does the above brief description of the changing structure of the world wheat market have to do with the introduction and production of medium-hard wheats in Canada? First of all, it shows that the world wheat market fluctuates quite considerably between being competitive in nature and being very oligopolistic in nature. Alaouze, Watson and Sturgess [1978] showed that the elasticity of supply from North American stocks is negative during price wars and that during such occurrences the demand facing the participants in the market-share oligopoly is inelastic. On the other hand, under "normal" conditions, namely when the oligopoly is adjusting its prices and quantities to shifts in the industry demand curve the elasticity of supply from stocks is positive. Such market phenomena complicate the estimation of the effect the introduction of a new technology (i.e. the production of medium-hard wheat in Canada) may have, depending on what the time frame chosen is.

A further complication arises when export wheat is not treated as a homogeneous product. It was earlier pointed out that wheat can be subdivided into many classes and types. Some of these are very close substitutes; others are not. Some exhibit "two-way" substitution, others exhibit substitutability only under certain conditions. (e.g.

Australian Prime Hard can substitute for Canadian Western Red Spring Wheat and vice versa, no matter what end-product they are used for. On the other hand, Australian Prime Hard can substitute for Australian Standarad White Wheat and vice versa if they are used for animal feed but not if they are used for pastry flour. American Hard Red Winter wheat with protein greater than 12 percent is very substitutable for American Dark Northern Spring Wheat, however, as the protein level drops below 12 percent it becomes much less substitutable.)

It was also pointed out earlier that different major exporters and importers characteristically restrict their exports and imports to one or two major classes of wheat (e.g. Canada exports mostly hard wheat, India imports mostly medium-hard wheat). It would thus be expected that in a given import market one or more of the major exporters may be, in fact, a fringe supplier because they don't export the class of grain that import market usually buys (e.g. in some Middle East countries Australia exports ten times the quantity of wheat that Canada exports because these countries want a medium-hard wheat, preferably with a white bran, and Canada is unable to supply such a product. Conversely, Australia sells very little wheat to the European market where high protein hard wheat is imported.)

Johnson, Grennes and Thursby [1977] constructed a trade model that distinguished wheat by country of origin in an attempt to quantitatively isolate some of the factors that have influenced the wheat trade of major wheat exporters in recent years. These included such things as tariffs, export taxes and transport costs. Such a trade model allowed a consuming region to distinguish among American,

Canadian and Australian wheat and to simultaneously purchase all, and at different prices. This is considerably more realistic than most trade models (e.g. Japan does, in fact, buy from many sources; Europe simultaneously imports and exports wheat).

Their model showed several things. First of all it showed that Australian wheat is much more substitutable and/or competitive with American wheat than is Canadian wheat[6] (e.g. a one percent increase in Australian wheat supply generated a 2.04 percent decline in the American domestic wheat price whereas a one percent increase in Canadian wheat supply generated a .46 percent decline in the American domestic wheat price, despite the fact that Canada is a larger wheat producer and exporter than Australia. Similarly a one percent increase in Australian exports to areas other than Japan and Europe generated a 1.85 percent rise in American domestic wheat prices whereas a one percent increase in Canadian exports generated only a .20 percent rise).

Secondly, the model showed, in order of magnitude, which factors have the most significant impact on American domestic wheat prices given a one percent change in the factor. (The percentage change it generated in American domestic prices is shown in brackets): (a) increase in American wheat supply (-3.78), (b) increase in Australian wheat supply (-2.04) (3) increase in American export areas other than Japan and Europe (1.85), (d) increased American domestic demand for

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[6] Although readers may question the absolute value of the numbers in the Johnson, Grennes and Thursby study, the authors are convinced that implied substitutability and/or competitiveness of American and Australia wheat is true.

feed (1.51), (e) increased Australian exports to areas other than Japan and Europe (1.35). These results show 1) the elastic nature of American domestic and foreign demand, 2) the great substitutability of Australian and American wheat (comparable figures for Canadian and Argentinian wheat showed a less than .5 percent effect on American domestic prices).

Using this information we can now go back and modify the Alaouze, Watson and Sturgess [1978] model of the world wheat triopoly. Suppose we divide the world market for wheat into the following three classes: 1) hard, 2) medium-hard and 3) soft.

These three markets are quite interrelated because of the substitution possibilities that can occur should the traditional premiums and discounts between classes change sufficiently.

In the hard wheat market the major exporters are Canada and the United States with fringe supplies coming from Australia and Argentina. This situation would very much represent McCalla's [1966] duopoly model of the wheat market. Canada and/or the United States are the price leaders and the holders of stocks, however, if they are forced to hold relatively high levels of this premium class of wheat they discount it sufficiently so that they can compete price wise in the medium-hard and/or feed wheat markets. Australia and Argentina are generally able to sell all their hard wheats at a price slightly below that of the price leaders without fear of retaliation.

In the market for medium-hard wheat the United States is by far the biggest supplier. Australia is the next biggest supplier with Argentina and Canada trailing far behind. Presently Canada and Argentina cannot really supply much into this market unless they are

willing to discount their poorer grades of hard wheat so they are competitive with the American and Australian medium-hard wheats.

In the market for soft wheat Canada and Argentina are once again very small or non-existent suppliers. The big suppliers are France and the United States. In this market France normally does not store grain because of "generous" EEC policies that encourage the quick export of any wheat in excess of EEC requirements. In addition, France is able to divert a considerable amount of its exports to former French colonies in the form of food aid.

Soft wheats generally give higher yields than hard or medium-hard wheats. For this reason most countries with a relatively moist climate prefer to grow soft wheat domestically and import hard wheat to blend with it. Similarly, soft wheat gives the highest yields of any class of wheat when grown under irrigation or high rainfall. (This is why it is generally the class of wheat grown under irrigation in Western United States and Canada and in the high rainfall areas of the EEC.)

Importers of soft wheat will generally use it for two purposes; animal feed or for human consumption. If they use it for human consumption they will most likely up-grade it by importing some additional hard wheat so a medium protein flour can be obtained (the demand for low protein flour products made solely from soft wheat is quite small). Thus, ceteris paribus, increased exports of soft wheat usually lead to increased exports of hard wheat as well, at least in countries that import both hard and soft wheat for blending. However, if total demand for wheat has not grown, then such increased exports of soft and hard wheat would have to come at the expense of

medium-hard wheat exports. (Thus it is possible that increased EEC wheat export subsidies will actually increase the demand for Canadian hard wheats.)

Such substitution possibilities mean that the prices of all classes of wheat generally move together but short term differences in physical quantities of each class available may alter the traditional discount and/or premium between the various classes and grades.

From the brief outline of the major and fringe suppliers of the three major classes of wheat it would seem quite possible that if Canada started producing more medium or soft wheat she could act very much as a fringe supplier in many of the traditional Australian and American markets and have little fear of price cutting behavior[7] as long as only a little market share was taken out of each market.

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[7] This, of course, assumes that Canada could compete in all the "non-price" ways that the USA and Australia are presently using in their traditional medium-hard markets (e.g. exporting bagged wheat when necessary, being able to extend credit or subsidize interest rates, blending wheats in Canada before export).

## CHAPTER IV

## PRICING CANADA'S MEDIUM-HARD WHEAT

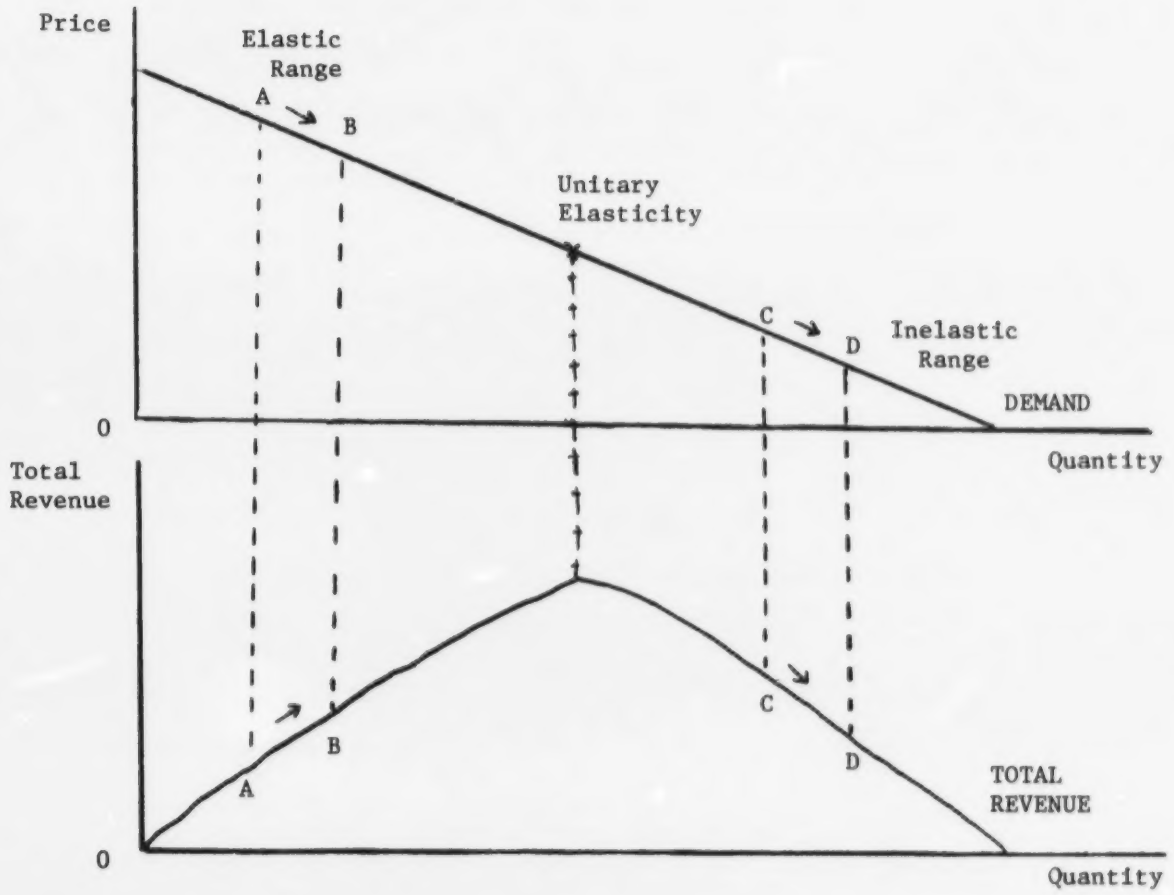
Before switching to the production of a higher yielding, lower priced wheat, farmers, grain industry personnel and the general public will be repeatedly asking themselves if the higher yields will more than compensate for the lower prices. Such a question is a very important one and the answer to it will largely determine whether or not Canada does indeed start producing significant quantities of medium-hard wheats. Although no one can predict what will occur in the future, economic theory based on past experiences can usually give us a good idea of what to expect in the future.

Recall that a supply curve is a graphical representation of how the quantity supplied of a commodity changes with a change in price. Supply curves almost always slope upward to the right because as the price of a commodity rises producers are more willing and able to produce increasing quantities of that commodity. Similarly, a demand curve is a graphical representation of how the quantity demanded of a commodity changes with a change in price. Demand curves almost always slope downward to the right because as the price of a commodity falls, consumers usually increase their purchases of that commodity.

The percentage change in quantity supplied or demanded, given a percentage change in price, is termed the supply or demand elasticity. If the quantity changes much faster than price the supply or demand is said to be elastic. If the quantity changes proportionately slower than price, the supply or demand is said to be inelastic.

The concept of elasticity of demand is very important in the analysis of the net benefits that can be expected from growing a higher yielding variety of wheat like HY320. This is so because the change in total revenue received, as quantity is increased, is directly dependent upon the elasticity of demand. (See Figure 1).

Figure 1: The Relation of Total Revenue to Elasticity of Demand



At the upper range of the demand curve, elasticity exceeds unity (i.e. the elasticity is greater than one) and the percentage increase in quantity sold is changing faster than the percentage decrease in the price. This means that total revenue is rising as the quantity sold increases. However, eventually a point is reached where the elasticity equals one. After this point is reached total revenue no longer increases as quantity sold increases (in fact, total revenue is maximized at the point where the elasticity equals one because it is only at this point that the percentage decrease in price is exactly countered by the percentage increase in quantity sold).

Beyond this point we reach the range where the demand curve is inelastic. This means that total revenue falls as more is sold so that the total revenue curve is now downward sloping.

Now consider this concept of elasticity of demand in light of the world demand for Canadian wheat exports. If the world demand for Canadian wheat exports is in the elastic range, Canadian wheat producers will enjoy increased total revenues as they increase export sales. On the other hand, if they are in the inelastic range, they will suffer lower total revenues as they increase sales. Thus, if we know what the elasticity of demand for Canadian wheat is, we can quickly estimate whether Canadian wheat producers will be better or worse off increasing wheat exports.

Unfortunately, the world wheat trade is far more complex than any economics text book might lead us to believe. In the long run, the world demand and supply of wheat is influenced mainly by the changes in population, tastes and preferences, incomes and technical change that takes place for wheat and its close substitutes and complements.

However, in the short run, annual changes in weather patterns and government policies in major importing and exporting nations have very pronounced effects on the slope and position of the world demand and supply curves of "traded" wheat. In addition, the annual size of wheat stocks carried over from one crop year to the next can have a dramatic effect on the "perceived" demand or supply of wheat.

For instance, the last few years have seen the Americans building up large stocks of wheat, particularly winter wheats.[8] These stocks are easily in excess of Canada's average total exports of wheat. The American economy, and consequently the American treasury, are 10-12 times as large as Canada's. Theoretically the Americans could "dump" all of their wheat stocks on the world wheat market at prices[9] sufficiently low that Canadian wheat exports would shrink to rather insignificant amounts. The American treasury would find it much less burdensome to pay American farmers the difference between the distressed world wheat price and the farm cost of production than would the Canadian treasury if it tried to help Canadian wheat producers in the same way.

Luckily for Canada, the Americans have never seen fit to carry this threat out to the extreme. However, there have been times when the Americans have exercised some market muscle by deliberately

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[8] For example, according to International Wheat Council statistics, American carryover and exports were about 42 and 43 million MT respectively in 1983 while Canada's carryover and exports were about 10 and 17 million MT respectively. Since 1980, American stocks have grown to the point where they are roughly equal to American exports.

[9] This could include such methods as greatly extending the American PL-480 program, the CCC credit program or the Food Aid program.

decreasing their traditional wheat stocks position until the smaller wheat exporters fell in line with American desires. For example, in the late sixties when Australian wheat production almost doubled, the Australians initially refused to increase their wheat stocks as well. An international wheat price war started - largely by the Americans "dumping" stocks - and continued until the Australians greatly expanded their stock holding capacity and willingly held stocks when the Americans and Canadians held stocks.[10]

Initially, the Australians correctly perceived themselves to be in the elastic range of the world demand for Australian wheat and thus increased production with the hope of increasing total revenue as well. However, eventually the Americans felt that Australian wheat exports were expanding too fast relative to the increased stocks the Americans were being forced to hold to keep world wheat prices relatively stable and high.

When the Americans decided to teach the Australians a lesson they started selling off their stocks. This had the net effect of moving the Australians to the inelastic range of the world demand for Australian wheat. Consequently, Australian total revenue increasingly fell as they tried to sell off all their last year's production. It eventually became apparent to the Australians that the Americans were bound to continue their price cutting behavior until they were convinced the Australians would henceforth do "their share" (i.e. by holding stocks) to keep world wheat prices high and/or stable during cyclical times when world wheat production far outstripped world wheat

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[10] See Alaouze, Watson and Sturgess [1978] for documentation.

consumption.

Similar price wars have emerged, from time to time, whenever one of the major wheat exporters, and particularly the Americans, perceived one of their major competitors was stepping beyond the boundary of what was considered a reasonable market share for the exporter in question. Of course, once such price cutting behavior takes place, the world demand for wheat from a particular origin may quickly and dramatically shift from the elastic to the inelastic range. Thus the threat of retaliation by its competitors may lead a wheat exporting nation to perceive that the elasticity of demand for its wheat is elastic only in the market share range that is acceptable by the wheat exporting nation with the biggest treasury. If this range is exceeded, the exporter may suddenly find itself sitting in a very inelastic part of the world demand curve for its wheat.

Such perceptions are very rightly real concerns to state wheat traders like the Canadian or Australian Wheat Boards. Perhaps this is the main reason why there appears to be such a wide gap between econometric estimates of the elasticity of world demand for Canadian wheat and the "gut" estimates of this same elasticity by officials of the Canadian Wheat Board and Canadian Grain Commission.

More specifically, over the last few years various studies of the Canadian wheat market have used world wheat exports and Canada's annual share of these to calculate elasticities of demand for Canadian wheat. Generally they have estimated this elasticity to be much greater than one (e.g. -6.0 or -11.5) and hence they have said that Canada could easily double or triple her wheat exports and still experience increasing total revenue. This, in turn, implies varieties

like HY320 should be licensed as soon as possible. On the other hand, many Canadian Wheat Board and Canadian Grain Commission officials say that at present the elasticity of demand for Canadian export wheat is less than one and Canada's total revenue will decline as we try to increase exports. This, in turn, implies that there is little merit in licensing varieties like HY320 at this time.

Who is right? History alone will be the final judge of which viewpoint was actually the correct one. At present, the best we can do is ask which viewpoint is most probable and reasonable and if it is possible to reconcile such a seemingly wide gap in final conclusions.

Firstly, econometric studies, by their very nature, require many observations if they are to be statistically significant. Because of this, they are usually based on ten or more years of data. This, in turn, means that the elasticity estimates they generate tend to be long term estimates. The Canadian Wheat Board, on the other hand, generally concerns itself with annual, monthly and even weekly changes in world demand and supply conditions. Thus their "gut" elasticity estimates tend to be short term estimates. The last few years have generally seen a build-up of world wheat stocks. Given such increases, it is easy to see why some wheat traders feel Canada has moved into an inelastic region of the world demand for Canadian wheat, at least in the short term. No doubt these same traders felt Canada was in a very elastic range a few years back when Canada's wheat sales were booming. Over the last ten years, would the short term high and low elasticities have averaged out to produce an average long term elasticity similar to that calculated by the econometricians?

Secondly, most of these recently released wheat studies employing econometrics have made little or no effort to incorporate the oligopolistic market structure of the world export wheat market. For instance, Canada's average market share for the last ten years is calculated and then inserted into equations that generate the supposed elasticity of world demand for Canadian wheat. The results inevitably show a very elastic range. However, they fail to analyze the extent of this elastic range. Exactly how much could Canada increase production before the Americans instigate a wheat pricing war? When are the Americans least likely to be concerned with erosion of their market share? What medium-hard wheat market shares can Canada most easily "nibble" from? How much market share could Canada take in each import market before the Americans or Australians retaliate?

These are some of the important questions that econometric studies generally fail to address, yet the present perceived answers to these questions may go a great deal toward explaining why there is such a difference between econometric estimates and Canadian Wheat Board "gut" estimates of the present elasticity of demand for Canadian export wheat.

## CHAPTER V

## ESTIMATING THE BENEFITS, IF ANY, FROM LICENSING HY320-TYPE WHEATS

The economic incentive for a farmer to adopt a medium-hard type of wheat depends to a large extent on his expectations of the yield increase, the sale price, the likely delivery quotas and the additional costs he can expect if he plants it. These values are compared in his mind with the expected values for traditional wheat types and also for all the other crops he can grow in his area.

For years, economists have constructed mathematical models (e.g. econometric models or linear programming models) to simulate farmers' seeding intentions. The accuracy of these type of models has varied greatly depending on how well expectations, risk, uncertainty and farmer's objectives were incorporated into the model. Generally speaking, as the accuracy of the model increases the complexity of the model increases.

This study does not attempt to construct or use any complicated mathematical models to predict the likelihood that farmers will adopt medium-hard wheat. Instead, it takes annual hard spring wheat production by crop district and compares the revenue earned by it with the revenue that might have been earned if all the hard spring wheat production in that area has been replaced by medium-hard spring wheat production.[11] The change in expected revenues is compared on an annual basis as well as over an eleven year period.

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[11] In other words, this study assumes a farmer has already made the decision to plant a given area to spring wheat. It compares the revenue from traditional hard red wheat with the expected revenue from a medium-hard spring wheat like HY320.

To do this, this study assumes that any licensed medium-hard wheat would have traits at least as good as those of HY320. The use of HY320 in this study is not an endorsement of its agronomic merit above other semi-dwarf medium-hard wheats. In fact, strains of semi-dwarf medium-hard wheats, now being developed by Agriculture Canada, yield more, are more disease resistant, take less time to mature and are less prone to sprouting than HY320. Some of these new strains even have a white, instead of red, bran colour. HY320 is to medium-hard wheat what Red Fife was to Hard Red Spring Wheat ninety years ago. The only reason HY320 is being used in this study is because yield and milling data on it are much more extensive and available than data from any other medium-hard wheat grown on the Prairies.

### 5.1 Comparing Farmgate Sales

This study compares a given crop district's annual production and sale of traditional and spring wheat varieties (i.e. CWRS) with that of HY320. In yield trials HY320 has always yielded more than CWRS wheats. Thus, whether or not CWRS or HY320 is grown, at least the CWRS level of production will be produced and hence the transport and handling costs needed to move at least the CWRS level of production will remain constant whether this quantity is made up of HY320 wheat or CWRS wheat. Production of HY320 over and above the CWRS level of production would have to bear additional farm, transport and handling charges. To incorporate these changes into the model, the gross sales of HY320 were calculated. From this sales figure the product of additional farm, transport and handling charges times the production of HY320 over and above the CWRS level of production was subtracted to

produce an HY320 gross farmgate sales figure that was comparable to the previously calculated CWRS gross farmgate sales figure. These calculations were as follows:

$$GAIN = NS_{HY} - NS_{CWRS}$$

$$NS_{CWRS} = WP_{CWRS} * PR_{CWRS} - [PR_{CWRS} * (TC_S + HC)]$$

$$NS_{HY} = WP_{HY} * PR_{HY} - [PR_{CWRS} * (TC_S + HC)] - [(PR_{HY} - PR_{CWRS}) * (TC_{US} + HC + FC)]$$

$$WP_{CWRS} = (P1_{CWRS} * G1_{CWRS} + P2_{CWRS} * G2_{CWRS} + P3_{CWRS} * G_{3CWRS} + PF_{CWRS} * GF_{CWRS})$$

$$WP_{HY} = (P1_{HY} * G1_{HY} + P2_{HY} * GR2_{HY} + PF_{HY} * GRF_{HY})$$

$$P1_{HY} = PF_{CWRS} + 2/3 * (P3_{CWRS} - PF_{CWRS})$$

$$P2_{HY} = PF_{CWRS} + 1/3 (P3_{CWRS} - PF_{CWRS})$$

$$PF_{HY} = PF_{CWRS}$$

$$G1_{HY} = G1_{CWRS} + 1/2 * G2_{CWRS}$$

$$G2_{HY} = G3_{CWRS} + 1/2 * G2_{CWRS}$$

$$GF_{HY} = GF_{CWRS}$$

$$PR_{HY} = PR_{CWRS} * RYA$$

where:

GAIN - refers to net gain, if any, from growing HY320 instead of traditional varieties.

NS - is the net value of sales after appropriate farm freight and handling charges have been deducted,

HY - refers to the nontraditional wheat HY320,

CWRS - refers to traditional hard red spring wheat varieties,

WP - is the weighted price of wheat after taking into account the grading pattern and the price for each grade,

PR - is the production level,

$TC_S$ and $TC_{US}$ - are the approximate subsidized and non-subsidized transport cost from the crop district in question to the nearest major port,

HC - is the approximate amount elevator companies would charge for handling grain from the crop district in question to the nearest major port,

FC - is the additional farm cost incurred when growing a higher yielding variety,

P1, P2, P3 and PF - are the prices of first, second, third and feed grades,

G1, G2, G3 and GF - are the percent of the total crop falling into first, second, third and feed grades,

RYA - is the yield advantage of HY320 over CWRS.

## 5.2 Grading Patterns

To do this, the estimated annual grading pattern of stored hard spring wheat for each crop district was collected from Canadian Wheat Board survey data (i.e. what percent of the total wheat crop was #1 CWRS, #2 CWRS, #3 CWRS and FEED CWRS in each of the crop years from 72/73 to 82/83. For interested readers, this grading data is shown in complete detail in an appendix.)

Most crop districts show quite a year-to-year variation in the percentage of each grade they produce. However, given enough years, one can say with quite a degree of confidence that a certain crop district usually produces a certain grade of wheat. For instance, the Peace River district of Alberta (Alberta Crop District #7) generally produces #3 and FEED CWRS. Table 4 illustrates this point.

From this grading data, the annual grading pattern of the HY320 crop was projected for each of the crop districts in the prairie provinces. Although grades for HY320 have yet to be established, several officials of the Canadian Grain Commission expressed the view that there will most likely be only two grades of HY320. They also

Table 4: The Historic Grading Pattern of Wheat in Alberta
C.D. #7 (72/73 - 81/82)

| Crop Year | % of Total Crop Falling Into Each CWRS Grade | | | | |
|---|---|---|---|---|---|
| | #1 | #2 | #3 | FEED | Total |
| 72/73 | 0 | 10 | 73 | 17 | 100 |
| 73/74 | 0 | 5 | 43 | 52 | 100 |
| 74/75 | 0 | 4 | 30 | 66 | 100 |
| 75/76 | 1 | 21 | 61 | 17 | 100 |
| 76/77 | 0 | 19 | 75 | 6 | 100 |
| 77/78 | 0 | 7 | 47 | 46 | 100 |
| 78/79 | 0 | 3 | 35 | 62 | 100 |
| 79/80 | 1 | 33 | 54 | 12 | 100 |
| 80/81 | 0 | 6 | 48 | 46 | 100 |
| 81/82 | 43 | 36 | 20 | 1 | 100 |
| 82/83 | 2 | 6 | 55 | 37 | 100 |

Source: Canadian Wheat Board Survey of Stored Grain (various years).

felt that areas that traditionally produce #1 CWRS and #3 CWRS would likely produce #1 HY and #2 HY respectively. In addition, areas producing #2 CWRS would likely produce an HY320 that would fall half in the #1 HY grade and half in the #2 HY grade. Areas that traditionally produce feed wheat would also produce a feed wheat grade of HY320.

This grade approximation was based largely on the fact that HY320 generally needs more days to mature than the traditional hard spring wheat varieties. One of the main degrading factors influencing the present hard spring wheat grades is the weather at harvest time, especially the incidence of rain and frost. Generally, the more northerly agricultural areas of the prairies have the shortest frost-free period and the greatest probability of rain during harvest.

Consequently, these are the areas that produce the greatest portion of the #3 CWRS and feed wheat grades. If HY320 were grown in these areas most of the HY320 production would probably fall into the #2 HY grade or the feed wheat grade. Figure 2 and Table 5 compare the present CWRS grades with the HY grades that were assumed in this study.

## 5.3 Prices

The prices originally used in this study were all basis Thunder Bay. In any particular location the farm price is thus the Thunder Bay price minus the handling charge minus the freight charge to the location in question. (Details of how handling and freight costs were actually calculated are given in subsequent sections.)

After the annual historic and projected grading patterns of each crop district were collected or estimated, they were multiplied by the annual final realized price received by farmers for each grade, basis Thunder Bay. This gave the weighted hard spring wheat farm gate price received annually in each crop district in the prairies. Generally, the more northerly crop districts experienced a weighted wheat price about 5 percent less than the more southerly crop districts, however, this difference widened, in rare instances, to almost 20 percent (e.g. in 82/83 the weighted wheat price in Saskatchewan Crop District #4 was $191.45 while it was only $159.72 in Saskatchewan Crop District #8 in the same year - a difference of 19.8 percent. This was due to the very poor grade of wheat produced in Crop District #8 in 82/83).

Complementary to the gathering of price data for hard spring wheat was the estimation of the prices of the assumed grades of HY320 in the years under question. Such estimation was extremely difficult because

Figure 2: Comparison of CWRS Grades and Tentative HY Grades

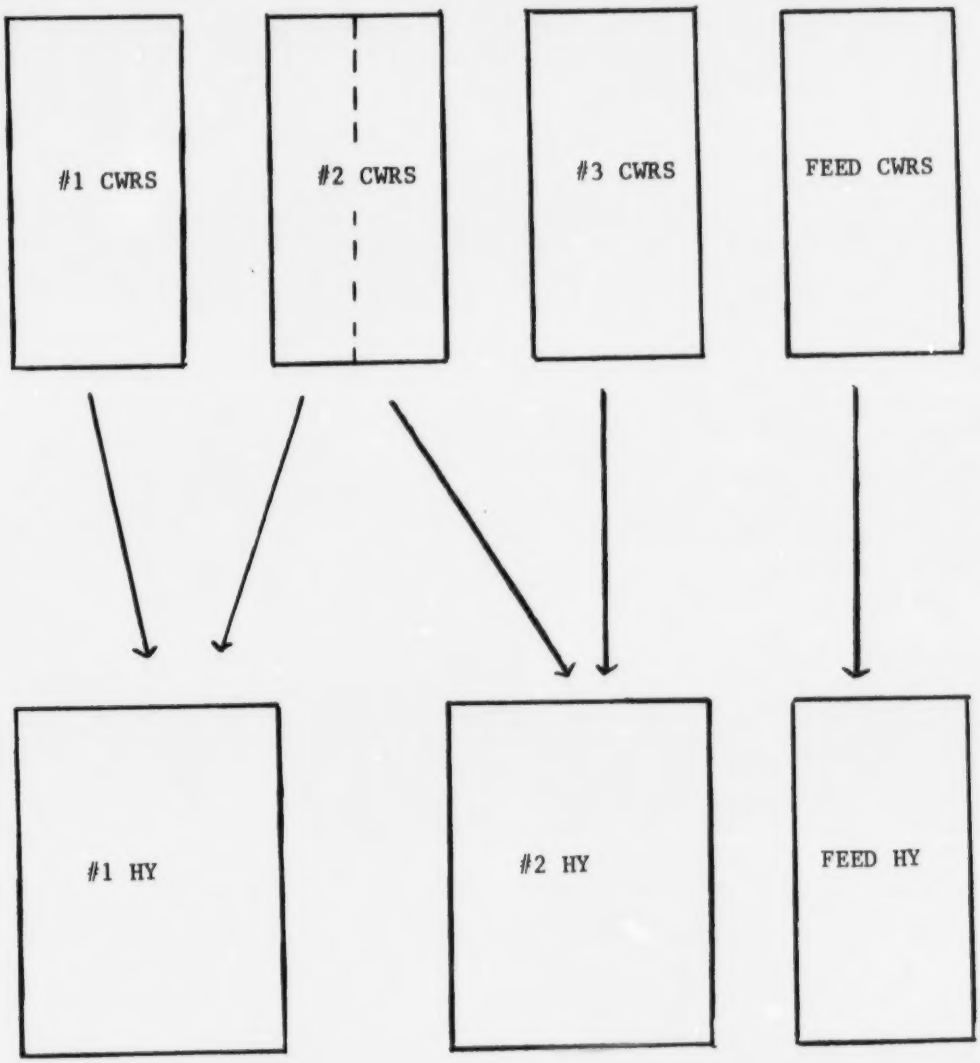

Table 5: The Tentative Grading Pattern of HY320 if it had been Grown in Alberta C.D. #7 (72/73-81/82)

| Crop | % of Total Crop Falling Into Tentative Medium-Hard (HY) Grade | | | |
|---|---|---|---|---|
| Year | #1 | #2 | FEED | Total |
| 72/73 | 5 | 78 | 17 | 100 |
| 73/74 | 3 | 45 | 52 | 100 |
| 74/75 | 2 | 32 | 66 | 100 |
| 75/76 | 11 | 72 | 17 | 100 |
| 76/77 | 10 | 84 | 6 | 100 |
| 77/78 | 3 | 51 | 46 | 100 |
| 78/79 | 1 | 36 | 63 | 100 |
| 79/80 | 17 | 71 | 12 | 100 |
| 80/81 | 3 | 51 | 46 | 100 |
| 81/82 | 61 | 38 | 1 | 100 |
| 82/83 | 5 | 58 | 37 | 100 |

Source: Authors' estimation

Canada does not presently sell significant quantities of medium quality wheats. However, about half the total American wheat crop and over 80 percent of the Australian wheat crop are medium quality wheats. Exports of HY320 wheat would generally sell in the same markets and at the same prices as the equivalent American or Australian wheats just as Canadian hard wheats presently compete with American, Argentinian and Australian hard wheats. Unfortunately, even in the hard wheat market the premiums and discounts between hard wheat from different origins are not constant over time.[12] If this were not

[12] This is often due to such factors as: 1) changing national economic policies, 2) political considerations, 3) long term purchase agreements, 4) temporary transportation and storage bottlenecks, 5) changing quality requirements of importers, 6) large importers making erratic but large purchases of certain classes of wheat, 7) erratic weather phenomena like early frost, 8) annual changes in the quality of exporter's wheat crops.

a big enough problem, the premiums and discounts between the various classes of wheat show even greater variability than those within the hard wheat class. The reasons for this are similar but more pronounced than those outlined previously for hard wheats from different sources. Even in a Canadian context this variability within a single class is obvious.

| Crop Year | #1 CWRS Final Price* | CWRS Feed Final Price* | Ratio of #1 to Feed Price |
|---|---|---|---|
| 1972-73 | 79.14 | 69.83 | 1.13 |
| 1979-80 | 196.43 | 126.82 | 1.55 |
| 1982-83 | 192.34 | 145.71 | 1.32 |

* Basis Thunder Bay

(Source: Canadian Wheat Board Annual Reports, various issues)

Such variability makes it extremely difficult to mathematically model the world market for medium quality wheat with any degree of accuracy. Various studies have tried to do this but with little apparent success. Because of the repeated lack of success in modelling the demand and supply of medium quality wheat by other economists and because of the extensive data requirements such a study would entail, the author chose a much simpler approach to approximate the prices that HY320 could have been sold for had it been grown in the period 72/73 to 82/83.

This simple approach was originally suggested by several members of the Canadian Wheat Board and the Canadian Grain Commission. It assumes that #1 and #2 CWRS are extremely close substitutes for each

other but that #3 and FEED CWRS fill fairly different market niches.

HY320 is a medium quality wheat and hence would likely be priced similar to #3 CWRS, however, the protein and gluten strength of HY320 tends to be less than #3 CWRS. This factor suggests that HY320 would have to be priced somewhat less than #3 CWRS but certainly more than CWRS FEED. This assumption is further strengthened by the fact that, generally, American Hard Red Winter ordinary grade wheat, an obvious substitute for HY320, is priced less than #3 CWRS but more than FEED CWRS.

The expected #2 HY grade would sell for a discount to #1 HY. There is no way to know precisely how much this discount would be. It seems reasonable to assume that in years when the discount between #3 CWRS and CWRS FEED is relatively large, the discount between #1 HY and #2 HY would also be relatively large. Similarly, when there is relatively little difference between #3 CWRS and FEED CWRS there would likely be little difference between the price of #1 HY and #2 HY. It was arbitrarily decided that the price of #1 and #2 HY would be the price of FEED CWRS plus 2/3 and 1/3 of the difference between the price of #3 CWRS and FEED CWRS.[13] Figure 3 illustrates this assumed price relationship. During the sensitivity analysis these price relationships were allowed to change somewhat.

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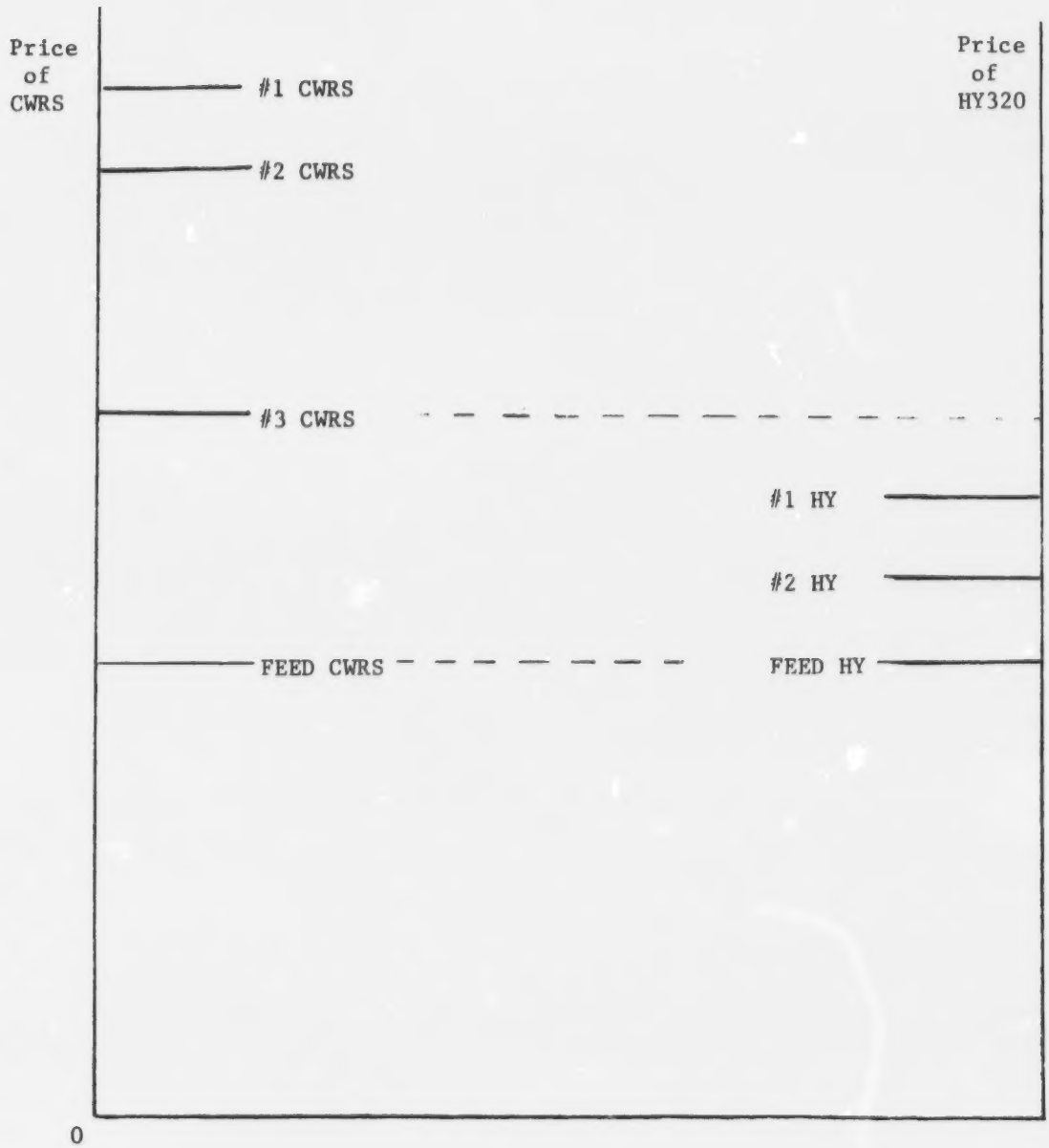
[13] For instance, if the price of CWRS FEED was $145.71 and #3 CWRS was $180.39 then the price of FEED HY, #2 HY and #1 HY was assumed to be $145.71, $157.27 and $168.83 respectively.

Figure 3: Comparison of CWRS Prices and Tentative HY Prices



## 5.4 Yields

HY320 wheat yields more than the traditional hard spring varieties like Neepawa (in fact the letters HY stand for high yielding) when both are grown under identical conditions, however, the magnitude of yield increase varies greatly between years and locations. This is illustrated in Table 6. Such variability is typical of cereal yield trials on the prairies. On the average, over all test locations and years, HY320 gave 1.293 times the yield of Neepawa.

Generally, HY320 had the highest yield advantage in the southern portion of the back soil zone (i.e. southeast Saskatchewan and southern Manitoba), followed by the northern portion of the black soil zone (i.e. all remaining black and gray soils in Manitoba, Saskatchewan and Alberta) and finally followed by the brown and dark brown soil zones in Saskatchewan and Alberta.

For the purposes of this study, each crop district was put into one of the three wheat agronomic zones (i.e. (1) Southern black soil zone - rust area, (2) Northern black soil zone - frost area, (3) Brown and dark brown soil zone). Large crop districts that stradled two zones (e.g. Crop District 4 in Alberta and Crop District 5 in Saskatchewan) were weighted by data from both applicable agronomic zones to take into account their position.

From the variety tests that were conducted since 1974, the annual average yield advantage of HY320 over Neepawa was calculated for each of the three wheat agronomic zones. These annual yield advantage figures were then multiplied by the annual production of hard spring wheat in each of the crop districts. The product thus obtained represented the amount of HY320 wheat that would have been produced

Table 6: Some Yield Trials Comparing HY320 with Neepawa (100 Kg/ha)

| Location | 1974 | | | 1977 | | | 1983 | | |
|---|---|---|---|---|---|---|---|---|---|
| | Neepawa | HY320 | RYA* | Neepawa | HY320 | RYA* | Neepawa | HY320 | RYA* |
| Regina | 19.6 | 20.0 | 1.02 | 46.4 | 63.6 | 1.37 | 27.8 | 37.0 | 1.33 |
| Winnipeg | 15.7 | 19.0 | 1.21 | 23.8 | 39.7 | 1.67 | 32.0 | 36.2 | 1.13 |
| Beaverlodge | 47.4 | 49.8 | 1.05 | 39.8 | 49.7 | 1.25 | - | - | - |
| Melfort | - | - | - | 37.0 | 1.4 | 1.39 | 31.1 | 32.4 | 1.04 |

*RYA = Relative Yield Advantage = $\frac{\text{Yield HY320}}{\text{Yield NEEPAWA}}$

Source: Ron De Pauw, HY320 wheat breeder, Agriculture Canada, Swift Current

annually in a crop district had all of the acreage of hard spring wheat been planted to HY320.

## 5.5 Extra Farm Costs

When a higher yielding crop like HY320 is grown a farmer must bear the extra cost of handling a greater volume of grain. For instance, he must make more trips between his combine and granaries and between his granaries and the grain elevators in town. He may also have to build or buy additional granaries if his present granaries are fully utilized growing hard spring wheat varieties. Higher yields may also lead to more wear on grain handling equipment such as augers, grain driers and combines. (On the other hand, because HY320 is a semi-dwarf type of wheat with much shorter straw, it may take fewer operations with harrows, diskers and cultivators to spread and

incorporate the straw after harvest).

Seed costs may be higher with HY320 because it is susceptible to smut and hence requires a seed applied fungicide, unlike traditional hard spring varieties. HY320 also has a larger kernel size and hence a given weight of HY320 contains fewer kernels than a traditional variety. To obtain the same number of plants per hectare, the seeding rate for HY320 must be higher than the seeding rate for traditional varieties. This tends to also raise the seed cost above that of traditional varieties. On the other hand, it is assumed that within a few years HY320 seed would sell for less than seed of traditional wheat varieties because, in the market place, a given weight of HY320 is less valuable than a given weight of a traditional wheat. This study assumes that the saving in seed cost due to HY320's lower market value would roughly compensate for the additional fungicide and seeding rate expense and hence that there is in total no significant seed cost difference between planting HY320 and a traditional hard spring variety.

The variable costs associated with a higher yield of grain are shown in Table 7. A low and a high estimate are given. These estimates were a consensus of cost estimates given by several farm management specialists from the University of Saskatchewan and several local farmers. They represent the cost per tonne for each additional tonne over and above the cost already incurred to harvest the base quantity of traditional wheat (hence they include an allowance for extra fuel, oil, repairs and labour to haul grain but they do not include an allowance for the fixed cost of the truck since it is assumed the fixed costs would be covered whether or not HY320 was

Table 7: The Variable Costs Associated with a Higher Yielding Variety of Wheat (81/82).

| Extra Cost Category | Low Estimate ¢/bus | Low Estimate $/MT | High Estimate ¢/bus | High Estimate $/MT | Medium Estimate ¢/bus | Medium Estimate $/MT |
|---|---|---|---|---|---|---|
| Storage (Assume full now, farmer will have to build extra storage) | 5.0 | 1.82 | 10.0 | 3.65 | 7.5 | 2.74 |
| Transport (Assume farmer has truck that is not fully used; marginal cost includes fuel, oil, repairs and labour) transport to granary and to elevator | 5.0 | 1.82 | 15.0 | 5.47 | 10.0 | 3.65 |
| Machinery (wear and tear on augers, combines, etc.) | 1.0 | .36 | 2.0 | .72 | 1.5 | .55 |
| Total | 11.0 | 4.0 | 27.0 | 9.85 | 19.0 | 6.94 |

Source: Consensus of several farmers and extension personnel.

grown).

It should be noted that there is no extra fertilizer cost associated with the higher yields of HY320 (this is in direct contrast to the assumption made in the recent Canada Grains Council's publication, Grain Grading for Efficiency and Profit). The reasons for this assumption are as follows. On the average, prairie soils are most deficient in two nutrients, nitrogen and phosphorus. Generally, in wheat, for every 10-15 percent increase in yield the protein content decreased by 1 percent. Thus HY320 has a protein content 2-3 percent lower than traditional spring wheat varieties. This inverse relationship between protein content and yield means that although the

yield of HY320 is higher, the nitrogen requirements for it may not be significantly higher than for traditional spring wheat varieties. Consider the following example. Protein content is generally estimated by taking the nitrogen content of a sample of wheat and multiplying by 5.75. Hauling away 2000 Kg. of 13.5 percent protein Neepawa wheat from a hectare of land would thus remove 47.0 Kg. of N (2000 Kg.*.135/5.75) while a 2600 Kg. crop of 11.5 percent or 10.5 percent protein HY320 would remove between 52.0 and 47.5 Kg. of N. (i.e. a low of 2600 Kg.*.115/5.75 to a high of 2600 Kg.*.105/5.75). In cases where HY320 yields less than 110 percent of the yield of traditional wheat, it may actually use less N than a traditional variety. In any case, the difference between the rate at which HY320 extracts N from the soil and the rate at which a traditional wheat extracts N from the soil is minimal. For this reason extra N fertilizer was not included as an extra cost in the production of HY320.

In most prairie soils plant available phosphorus is released slowly from the large bank of "plant unavailable" phosphorus in the soil. By weight, wheat contains about .5 percent phosphorus. A 2000 Kg. crop of wheat would thus contain about 10 Kg. (2000 Kg.*.005) of P and a 2600 Kg. crop of HY320 would contain about 13 Kg. of P (2600 Kg.*005). This difference of 3 Kg./ha is relatively negligible compared to the total "Bank" of phosphorus available in most prairie soils. Thus no extra P fertilizer cost was included as an extra cost

in the production of HY320.[14]

Once these variable costs were estimated for 1982/83, they were adjusted by the Saskatchewan Agriculture Index of Farm Input Costs to come up with a reasonable annual estimate of the total extra variable costs per metric tonne that might have been incurred by farmers had they been able to grow HY320 in the years in question. These calculations are shown in Table 8.

## 5.6 Handling Costs

On the Prairies, grain companies charge farmers a fee to cover the expenses the grain company incurs between the time the farmer delivers his grain in the elevator and the time the grain is placed in terminals at various ports. These charges are normally referred to as handling charges and cover such things as interest on grain in transit, building amortization, maintenance and repair and elevator agent's salaries. These rates are normally set once a year and are constant throughout the grain company's elevators regardless of their location.

When a new higher-yielding crop like HY320 is grown, one could argue that the handling charges for the incremental production would be very small because most of these costs are fixed (the biggest exception being interest on grain in transit). On the other hand, storage facilities may have to be expanded faster than if only traditional varieties had been grown. Because of the debatable

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[14] This view was confirmed by Les Henry of the Soil Science Department, University of Saskatchewan.

Table 8: Annual Total Variable Costs Associated with a Higher Yielding Variety of Wheat (72/73-81/82).

| | Index of Total Farm Input Costs[1] | Total Additional Cost/Mt |
|---|---|---|
| 1972/73 | .398 | 2.79 |
| 1973/74 | .462 | 3.23 |
| 1974/75 | .522 | 3.65 |
| 1975/76 | .560 | 3.92 |
| 1976/77 | .575 | 4.02 |
| 1977/78 | .650 | 4.55 |
| 1978/79 | .762 | 5.33 |
| 1979/80 | .838 | 5.87 |
| 1980/81 | .971 | 6.80 |
| 1981/82 | 1.000 | 7.002 |

[1] Adapted from Saskatchewan Agriculture, Agricultural Statistics 1982, "Index of Farm Input Costs".

[2] The figure of $6.94/MT in Table 7 was rounded up to $7.00/Mt and then used as the base for the above calculations.

question of how much marginal handling costs would actually change with increased throughput, the authors' decided to be conservative and assume handling charges would not have been any less than they historically had been. Thus the rates used in this study for the incremental HY320 production were the historic rates charged for wheat by the Saskatchewan Wheat Pool. These are shown in Table 9.

### 5.7 Extra Transport Cost to Ports

A final and controversial additional cost that might be incurred when a higher yielding wheat is produced is the extra transport costs required to bring it to export position, be it Thunder Bay, Vancouver, Churchill or Prince Rupert. The recent election of the Progressive Conservative Party at the national level throws even more uncertainty

Table 9: Primary Elevator Handling Charges

| Year | Charge[1] (¢/bus) |
|---|---|
| 1972/73 | 5.750 |
| 1973/74 | 6.250 |
| 1974/75 | 8.750 |
| 1975/76 | 11.000 |
| 1976/77 | 11.625 |
| 1977/78 | 13.625 |
| 1978/79 | 14.750 |
| 1979/80 | 14.750 |
| 1980/81 | 17.100 |
| 1981/82 | 18.570 |
| 1982/83 | 19.570 |

[1] Includes both handling and elevation and removal of dockage.

Source: Vern Schite, Saskatchewan Department of Agriculture

into the projection of future freight rates for prairie grains (e.g. will recent freight increases be rolled back, will the C.A.P. - the maximum amount of grain exports eligible for the government subsidized freight rate be removed, will railways be allowed to charge differential freight rates?).

The authors of this report calculated two sets of results; the first did not include any extra freight component, the second included a high freight component that hopefully captured the maximum difference in freight rates between crop districts that may occur under the new distance related freight rate schedule that came into effect on August, 1984. Only the results assuming the high freight rate are presented. The results are quite similar to those using low freight rates except that farmgate net sales increase to the extent that the total freight cost is lessened.

Formerly the freight rate charged for each MT of wheat was based on approximately 40 kilometre units of distance. For instance, all delivery points with a distance of 800-840 kilometers might have had the same freight rate, those from 840-880 kilometers a slightly higher rate and so on. Under the new freight rate schedule, such "step-wise" jumps in freight rates have been replaced by rates that vary more directly with distance. Hence, under the new schedule, delivery points 800, 805 and 820 kilometers apart all have a different freight rate.

Approximate transport rates to each crop district were estimated in the following way. In each crop district a delivery point was picked that seemed reasonably representative of the whole district. This point was normally located near the centre of the district and/or had a freight rate that fell in the mid-range between the highest and lowest rates found in that district. These rates were then divided by the freight rate for Scott[15] to obtain a ratio that expressed the crop district rate as a portion of the Scott rate. These are shown in Table 10.

At the worst, all the production of HY320 in excess of the production level of CWRS would have had to have been shipped at the non-government subsidized rate (i.e. the "non-Crow" or full compensatory rate). To estimate what this rate would have been, the

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[15] For years, data has been published on the freight and handling costs from Scott, Saskatchewan to various port positions. Scott is approximately equal distance from Vancouver and Thunder Bay and hence has been treated historically as the epitome of a typical prairie delivery point.

Table 10: Grain Freight Rates of Selected Points Compared to the Freight Rate for Scott, Saskatchewan

| Province | Crop District | Representative Delivery Point | Ratio of Delivery Points Rate to Scott's Rate |
|---|---|---|---|
| Manitoba | 1 | Melita | .758 |
| Manitoba | 2 | Oak Lake | .743 |
| Manitoba | 3 | Oak Burn | .758 |
| Manitoba | 4 | Roblin | .790 |
| Manitoba | 5 | Swan River | .820 |
| Manitoba | 6 | Gilbert Plains | .774 |
| Manitoba | 7 | Gladstone | .696 |
| Manitoba | 8 | Morden | .696 |
| Manitoba | 9 | Carey | .665 |
| Manitoba | 10 | Beausejour | .618 |
| Manitoba | 11 | Stonewall | .618 |
| Manitoba | 12 | Arborg | .681 |
| Saskatchewan | 1 | Carlyle | .790 |
| Saskatchewan | 2 | Bechard | .851 |
| Saskatchewan | 3 | Gravelbourg | .930 |
| Saskatchewan | 4 | Consul | 1.023 |
| Saskatchewan | 5 | Foam Lake | .851 |
| Saskatchewan | 6 | Allan | .941 |
| Saskatchewan | 7 | Kerrobert | 1.023 |
| Saskatchewan | 8 | Melfort | .930 |
| Saskatchewan | 9 | Mayfair | 1.023 |
| Alberta | 1 | Buffalo | .960 |
| Alberta | 2 | Taber | .946 |
| Alberta | 3 | Stavely | .898 |
| Alberta | 4 | Irma | .914 |
| Alberta | 5 | Ponoko | .930 |
| Alberta | 6 | Smokey Lake | .898 |
| Alberta | 7 | Eaglesham | .930 |

Source: Canadian Freight Association, Tariff CFAW 4310 (May 24, 1984)

Snavely Report[16] was used to approximate what the full compensatory rate would have been at Scott, Saskatchewan. These calculations are shown in Table 11. These rates were then multiplied by the appropriate ratios in Table 10 to come up with the annual subsidized and nonsubsidized freight rates for each prairie crop.

Once the subsidized and non-subsidized freight rates were calculated for each year and crop district under study, they were combined with the previously described data on annual yield trials, additional farm costs, handling charges, production levels, grading patterns and prices to produce the gain, if any, that would have been generated by planting HY320 instead of CWRS.

### 5.8 The Results Under Several Scenarios

Once the data was collected and the hopefully appropriate assumptions made, the equations listed in Sub-Section 5.1 were evaluated annually for each of the 28 crop districts in question for the eleven years under study (i.e. a total of 308 net gain calculations). This answered the question "what would be the gain possible from growing HY320 if farmers had perfect knowledge in the spring of the grade pattern, price levels and relative yield advantage that they would experience in the fall?" It also served as data to calculate whether a crop district would have been better or worse off, after eleven years, if it grew only HY320 or only CWRS for the entire eleven year period.

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[16] Snavely, King and Associates, 1980 Costs and Revenues Incurred by Railways to Transport Grain Under the Statutory Rates, 1982.

Table 11: Approximate Annual Non-subsidized Freight Rate for Grain from Scott, Saskatchewan to Thunde Bay/Vancouver

| Year | Ratio of Full Cost Over Crow Rate | Crow Rate $/MT | Full Cost $/Mt | Difference $/MT |
|---|---|---|---|---|
| 1972/73 | 2.41[e] | 5.07 | 12.22 | 7.15 |
| 1973/74 | 2.57[e] | 5.07 | 13.03 | 7.96 |
| 1974/75 | 2.75[d] | 5.07 | 13.94 | 8.87 |
| 1975/76 | 2.94[e] | 5.07 | 14.91 | 9.84 |
| 1976/77 | 3.14[e] | 5.07 | 15.92 | 10.85 |
| 1977/78 | 3.36[e] | 5.07 | 17.04 | 11.97 |
| 1978/79 | 3.59[e] | 5.07 | 18.20 | 13.13 |
| 1979/80 | 3.84[e] | 5.07 | 19.47 | 14.40 |
| 1980/81 | 4.10[d] | 5.07 | 20.79 | 15.72 |
| 1981/82 | 4.38[e] | 5.07 | 22.21 | 17.14 |
| 1982/83 | 4.68[e] | 5.07 | 23.73 | 18.66 |
| 1983/84 | 5.00[e] | 5.07 | 25.35 | 20.28 |

[d] Derived from Snavely, King and Associates, 1980 Costs and Revenues Incurred by Railways to Transport Grain Under the Statutory Rates, 1980.

[e] Derived from extrapolation.

The initial results showed that the economic incentive to grow HY320, expressed as the percent increase in farmgate wheat sales, depended most upon the historic grading pattern an area experienced. The historic grading pattern was, in turn, associated with the soil zone the area was in. Generally, the brown-soil zone (high-grading) crop districts had less incentive to adopt HY320 than the black and gray (low-grading) crop districts. However, the most unusual finding

was that all crop districts would be somewhat better off if they grew only HY320 and could sell it at prices competitive with American and Australian medium-hard wheats.[17] These results were obtained, even after the non-subsidized freight rate was paid on the HY320 production that was in excess of the historic production of CWRS. Total farmgate wheat sales, for all the Prairies, increased by 10 percent with total wheat production[18] increasing by 29 percent and total freight for hauling wheat increasing by 102 percent.

Table 12 shows a few examples of the percent increase in farmgate wheat sales that would have been experienced by several representative crop districts under the original price scenario where HY320 was price competitive with American and Australian medium-hard wheat.

Although all crop districts gained, the crop districts in the black soil zone gained the most. This was expected because: 1) the black soil zone crop districts, on the average, have lower grades than the brown soil zone crop districts - hence they experience a relatively smaller price decline when they switch from CWRS to HY320, 2) the relative yield advantage of HY320 is greater in the black soil zone than in the brown soil zone, 3) the brown soil zone crop districts have generally higher freight rates than most black soil zones - thus favouring the shipment of CWRS which has a higher value

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[17] It should be recalled that this was the result after a total of eleven crops had been grown. In almost every year there were situations where a crop district would have been worse off switching to HY320, however, the gains made by switching in some years more than compensated for the losses sustained in other years.

[18] Throughout the following sections, this figure refers to the total production of HY320 and CWRS wheat; it does not include durum, soft wheat or winter wheat production.

Table 12: The Percent Change in Farmgate Wheat Sales if HY320 had been Grown Instead of CWRS*

| Crop District | Soil Zone | % Change (Total Effects after 11 Years) |
|---|---|---|
| Sask - 4 | Brown | 107 |
| Sask - 5 | Black (Southern) | 113 |
| Sask - 7 | Brown | 108 |
| Alta - 2 | Brown | 108 |
| Alta - 7 | Black (Northern) | 111 |
| Man - 4 | Black (Southern) | 115 |
| Man - 8 | Black (Southern) | 114 |

*These results are based on the estimated annual grading pattern for HY320 where:

HY FEED sells for CWRS FEED price

HY #2 sells for CWRS FEED price plus 1/3 times (CWRS #3 price - CWRS FEED price)

HY #1 sells for CWRS FEED price plus 2/3 times (CWRS #3 price - CWRS FEED price)

to weight ratio than does HY320. Of these three factors, the average grade of wheat a crop district produced had, by far, the greatest effect on determining the percentage gain in farmgate sales that a crop district would experience by switching to HY320.[19] Because of the dramatic nature of these results several other price scenarios were tried to get a better idea of how the results changed as various price assumptions were relaxed. Maps in the Appendix show the likely location of HY320 production under all the price scenarios that were tried.

[19] Similarly, a farmer who generally produces a lower grade of wheat would have more incentive to adopt HY320 than his neighbor who generally produces a higher grade of wheat, even though they might live side-by-side.

The second price scenario that was tried was to assume that all HY320 production would be sold at no more than historic export feed wheat prices. Keep in mind that these calculations total up the gains and/or losses from each of the eleven years from 72/73 to 82/83. If the total gain after eleven years was positive, it is assumed only HY320 was planted in each year; if it is negative it assumes that only CWRS was planted in each year. If HY320 is grown, the production in excess of the CWRS production is assumed to be shipped at the non-subsidized rate. Thus, if HY320 were sold only at feed prices, it is assumed that all of the HY320 production could be disposed of in export or domestic markets at a price no lower than the historic export feed wheat price because sufficient non-subsidized freight has been subtracted to ensure that all the extra production could actually reach export positions and thus not unduly depress the feed wheat price on the Prairies.

When all HY320 was simulated to be sold at feed wheat prices, many crop districts stopped producing HY320. These included all the crop districts in the brown soil zone as well as Crop District #3 in the black soil zone in Alberta. Black soil zone Crop Districts #8 and #9 in Saskatchewan were borderline cases, gaining only marginally by growing HY320.

The total increase in net farmgate sales was only one percent higher than what it had been historically even though total wheat production had increased by 15 percent. The total transport cost to handle this production level increased by 50 percent over what is was formerly when only CWRS was grown. Under this price regime 44 percent of Prairie spring wheat production was CWRS and 56 percent was from

HY320 (remember this does not include Durum or soft wheat production).

A third price scenario assumed that because the introduction of HY320 would take a significant portion of total wheat acreage out of CWRS production and because Canada is still the largest exporter of hard wheat; the price premium for #1 and #2 CWRS would rise 10 percent above what it had been historically. This was simulated by raising the price of #1 and #2 CWRS by 10 percent while leaving the price of #3 CWRS, FEED CWRS and HY320 the same. When these changes were run through the computer they showed fairly similar results to the second price scenario just described, however, only the brown soil zone crop districts did not grow HY320. Farmgate sales increased by 10 percent over what it had been historically. However, only three percent of this increase was due to switching from CWRS to HY320. The rest was due to higher prices for #1 and #2 CWRS. Total spring wheat production increased by 16 percent and the freight cost to handle this extra production was 52 percent more than what it was formerly. Prairie spring wheat production (excluding Durum and soft wheat) was composed of 42 percent CWRS and 58 percent HY320.

A fourth price scenario was also tried. It was based on the same assumption as the third price scenario, except that the price premium for #1 and #2 CWRS was allowed to rise by 20 percent instead of 10 percent. With such a high premium for #1 and #2 CWRS, it was not surprising that a lot less HY320 was produced. In addition to no HY320 production in the brown soil zone, there was no HY320 production in some of the black soil zones. These included Saskatchewan Crop Districts #1, #8 and #9, Alberta Crop Districts #3 and #4 and Manitoba Crop Districts #1, #7 and #8.

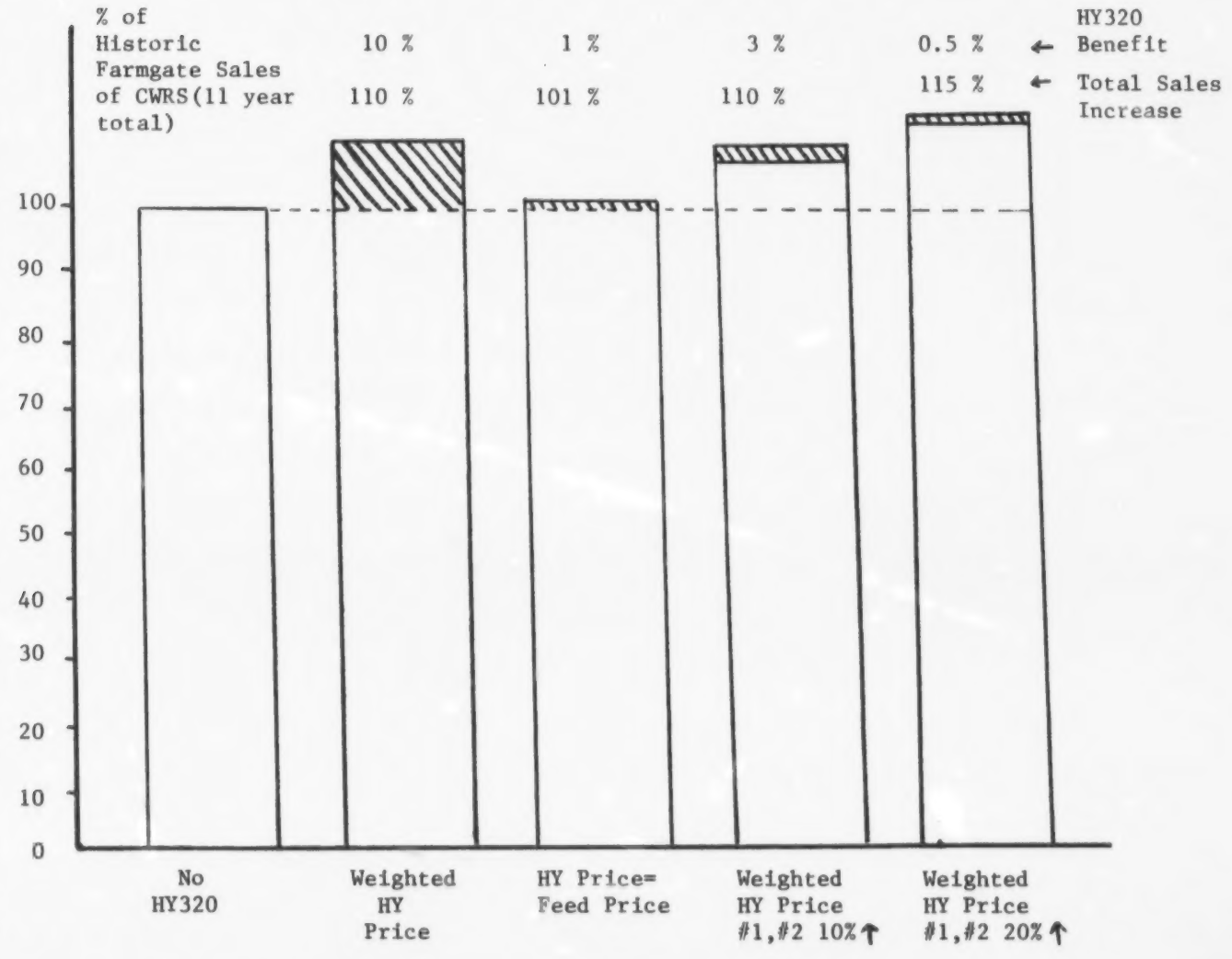
In this case, the total farmgate wheat sales was 15 percent higher but only 1/2 percent of this increase was due to the gain from shifting to HY320 from CWRS in some crop districts. In this situation, only 26 percent of the wheat produced was from HY320; the remaining 74 percent was from traditional CWRS varieties. (Hopefully Figure 4 will clarify the change that occurred in total farmgate wheat sales under each of the price scenarios.)

Finally, an analysis was conducted to find out how much lower all wheat prices would have to decrease before total farmgate sales, when both CWRS and HY320 were grown, fell to the same level as it was when only CWRS was grown. For this analysis it was assumed that the price relationship between HY320 and CWRS was that of either the just described first or third price scenario. (These were chosen because they were considered to be the most likely.) The results, under both of these situations, were very similar. All wheat prices would have to fall by 8-9 percent before there was no net gain in the farmgate wheat sales.

In most crop years and situations it is unlikely that Canadian wheat prices would drop by 8-9 percent with a 15-30 percent increase in Canadian wheat production. For instance, in this crop year (i.e. 1983/84) Canadian wheat production is 25-30 percent less than historically because of the prolonged drought, yet Canadian wheat prices have not changed significantly. However, it is possible that a 8-9 percent price decrease could take place with a 15-30 percent increase in Canadian wheat production if the Americans decided to "dump" its stocks until Canada withdrew from the production of medium-hard wheats. Although such a move is technically possible, it

is, for political reasons, unlikely to happen. Because of the small probability that the Americans would react in such a negative manner, it is, conversely, highly probably that most Prairie farmers would gain substantially if HY320 were licensed. The lower grading areas would gain by trading off a small price cut for a large yield increase; the better grading areas would gain by having the same or higher historical prices for hard wheat and larger than historic delivery quotas (although no value was put on this latter benefit).

Figure 4: The Effect on Total Farmgate Wheat Sales



# CHAPTER VI

## THE COST OF NOT LICENSING HY320-TYPE WHEATS

What is the cost to Canada of not licensing HY320-type wheats at this time? Such a question, if it is to be meaningful, must have a string of qualifiers attached to it. For instance, are only short term costs considered (e.g. the foregone farmgate sales in 1984)? Should long term costs be included as well? (e.g. if Canada doesn't license HY320, wheat breeders may get disheartened and drop their medium-hard breeding programs - this could have a devastating effect on Canada, vis-a-vis our competitors, if, in ten years time, new technology does awaywith the need for hard wheat). Are the present costs of not licensing HY320-type wheats the difference between what our wheat revenue actually was and a conservative estimate of what it might have been had HY320-type wheats been licensed?

Should such costs include public costs and benefits as well as those of the private sector? Should possible multiplier effects be included? How should the possibility of American retaliation be handled? Whose viewpoint of the present and future wheat market is most correct?

The authors do not attempt to answer all of these questions. They do, however, have an indication of the magnitude of the farmgate wheat sales farmers might have lost over an eleven year period because Canada was not producing or exporting a significant amount of medium-hard wheat. This estimated loss can be considered a minimum estimate for the following reasons:

1) No profitable increased stubble cropping is considered.

2) No profitable switching from barley, durum and other crops is calculated.

3) No introduction of better HY320 - type wheat varieties is modelled.

4) Full compensatory freight rate is assumed paid on all the additional HY320 yield.

5) No improved management of HY320 is allowed.

6) No multiplier effect of foregone additional wheat sales are considered.

Although the authors have estimated the lost revenue for each year from 1972/73 to 1982/83, the total of these losses may be somewhat misleading because of several factors. These include the fact that inflation accelerated rapidly toward the end of this period and a dollar lost in 1973 was certainly a bigger loss in real terms than a dollar lost in 1982. Secondly, there was a significant transportation constraint throughout much of this period. Although the incremental transport costs used in this study are the compensatory rates and hence, sufficiently high that trains could have been theoretically rented from American railways, some might argue that such rentable American trains would not always have been available in the 1970's. (Fortunately, for Prairie farmers, the early 1980's saw an easing of these transportation constraints and hence this is much less of an objection in recent years).

In an effort to avoid some of these problems, the authors tried to estimate the losses that may have been incurred in just one very recent crop year (i.e. 1982/83). The method used to make this estimate was a rough one and hence the estimate should be seen as an

indication of the magnitude of the losses rather than as a very precise figure.

Taking into account the very conservative approach that was taken and the percentage gains shown in Figure 4, the authors felt that in 1982/83 farmgate spring wheat sales could have been 5 to 10 percent higher than they actually were in that crop year, if HY320-type wheats had been licensed and adopted in those areas of the Prairies where there was an economic incentive to grow these types of wheat.

In 1982/83 total CWRS wheat production was around 22,000,000 MT worth, at the farmgate, about $4,000,000,000.[20] If this sales value could have been increased by 5 to 10 percent by allowing some farmers to switch to HY320-type wheat, then at least $200,000,000 to $400,000,000 was lost in 1982/83 by not allowing some farmers to switch to these types of wheat. These losses could be increased by another $75,000,000 if farmers don't have to pay compensatory freight rates on the incremental production from the HY320-types. These rough calculations are summarized in Table 13.

The reader is further reminded that these foregone farmgate sales actually represents foregone net farm income since 1) all the variable costs associated with growing, handling and transporting the incremental production from HY320 has already been deducted, (2) the fixed costs have been paid for, whether or not HY320 is grown.

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[20] These figures were obtained by rounding off the numbers appearing in the Canadian Wheat Board Report to Producers on the 1982/83 Crop Year. They include relatively insignificant quantities of winter and soft wheats.

For comparison purposes, in 1982, Realized Net Income of Farm Operators from Farming Operations in Manitoba was $223,000,000, in Alberta $594,00,000 and in Saskatchewan $912,000,000.[21] Thus, the annual average cost to Canada of not licensing medium-hard wheat could be approximately equivalent to not allowing anyone to farm in Manitoba or to closing down a third of Saskatchewan's farmland!! In other words, total Prairie net farm income could have been increased by 14 to 24 percent if HY320-type wheat had been licensed and widely grown and the federal government had no "cap" on grain freight rates.

Table 13: Approximate Minimum Foregone Farmgate Wheat Sales in 1982/83

| | Increase in Farmgate Sales | |
|---|---|---|
| | 5% | 10% |
| Foregone farmgate sales (i.e. 5% or 10% of 82/83 CWRS sales of 82/83 production of 22,000,000 MT valued at $4,000,000,000) | $200,000,000 | $400,000.000 |
| Additional non-Crow freight paid on incremental HY320 yield (.16*24,000,000MT*$20.00/MT) | 75,000,000 | 75,000,000 |
| Foregone Net Income if all HY320 shipped at Crow Rate | $275,000,000 | $475,000,000 |

Note: For comparison purposes, the 1982 Realized Net Income from Farming Operations is shown below:

| | |
|---|---|
| Manitoba | $223,000,000 |
| Saskatchewan | 912,000,000 |
| Alberta | 594,000,000 |
| Prairie Total | $1,728,000,000 |

[21] Statistics Canada #21-202.

# CHAPTER VII

## SUMMARY AND CONCLUSIONS

On the Canadian Prairies, farmers are increasingly growing medium-hard, semi-dwarf wheats, particularly in Manitoba. Until now, no wheat of this type has been licensed. In the last two years the Canadian Wheat Board has instituted a contract program with farmers to grow a strain of medium-hard, semi-dwarf wheat called HY320. Presently, the Canadian Wheat Board and the Canadian Grain Commission are using the production from these HY320 contracts to test market it in countries that traditionally consume medium-hard wheat from the USA and Australia or low grades of hard wheat from Canada.

If HY320 proves comparable to American or Australian medium-hard wheats in overseas markets, it will probably be licensed. This study tried to estimate where, and to what extent, HY320 will likely be planted if it is licensed. It also attempted to estimate the change in total farmgate wheat sales that might be expected if HY320 were licensed. Lastly, it very conservatively estimated how much net farm income Canada may be losing by not licensing medium-hard wheats like HY320.

Very briefly, the results of this study showed that the farmers in the black soil zone have much greater financial incentive to switch from growing CWRS to growing HY320-type wheats, than do farmers in the brown soil zone. This is particularly so in areas of the black soil zone where grades of CWRS are traditionally low (e.g. Peace River District in Alberta). Given even quite extreme price scenarios, some areas of the black soil zones would have no incentive to switch back

to CWRS varieties once HY320 type wheat were licensed.

Total farmgate wheat sales (not including durum or soft wheat) would likely be at least 5 to 10 percent higher if HY320 type of wheat were licensed. Such a sales increase would be associated with an increase of 15 to 30 percent in volume of wheat produced and in handling charges paid to grain companies. If this incremental volume was hauled to export positions under compensatory freight rates, the cost of freight would rise 50 to 100 percent.

Since additional freight, handling and additional necessary farm production costs were subtracted before the total farmgate sales comparisons were made, the foregone farmgate sales figure actually represents foregone net farm income. It was estimated that the present cost to Canada of not licensing medium-hard wheat is of at least the same magnitude as the 1982 realized net farm income from farming of all farmers in Manitoba (i.e. $200 to $400 million dollars).

There are several compelling reasons to believe that this estimated cost is, on the average, indeed a minimum one. However, there is a small chance that this cost would be greatly exaggerated if the licensing of HY320 led to a price war among the major wheat exporters. Such an occurrence is possible but rather unlikely.

There is little doubt that Canada could be, on the average, losing hundreds of millions of dollars annually by not licensing medium-hard wheats. This is not to say that any one individual or group of individuals is to blame for this situation. It does, however, point out the great and urgent need to re-examine the regulations and institutions that served us well in the past, to see if they have

become to rigid and unresponsive under present conditions. Such a re-examination will hopefully be seen as a desire for a better future and not as a damnation of the past.

Surely such enormous losses warrant fast and immediate attention. Canada is supposedly a sophisticated, developed nation. Should it be that difficult, then, to change our wheat licensing, grading, handling and exporting institutions to reflect more quickly the changing nature of wheat importing nations?

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# APPENDIX

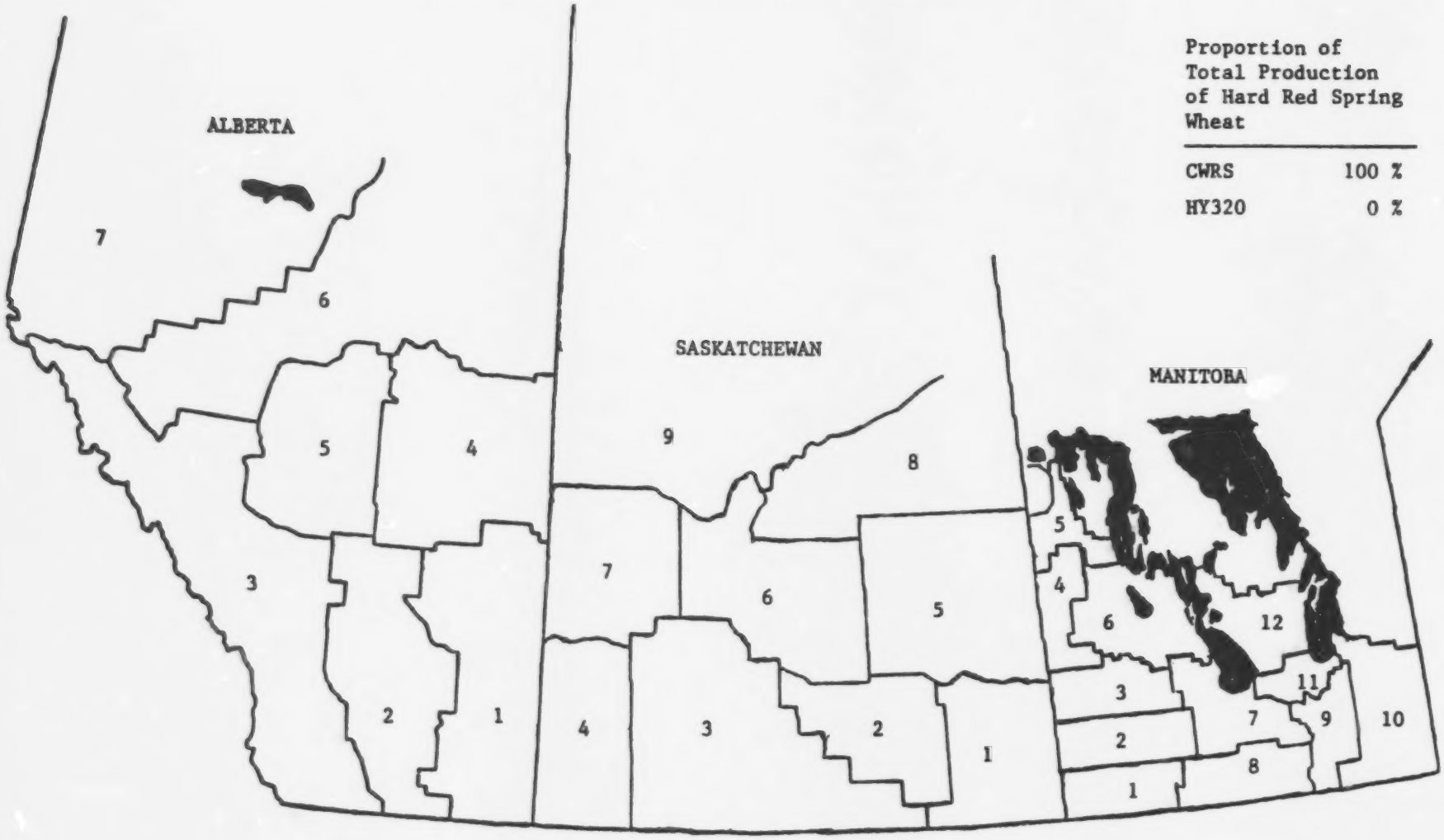
(i) Maps showing where the strongest economic incentive exists to grow HY320 - type wheats instead of traditional CWRS varieties under several relative price scenarios.

(ii) Praire crop district annual CWRS grade breakdown (72/73 to 82/83)

NOTE: column 1 = the crop year
column 2 = the proportion of the crop grading # 1 CWRS
column 3 = the proportion of the crop grading # 2 CWRS
column 4 = the proportion of the crop grading # 3 CWRS
column 5 = the proportion of the crop grading FEED CWRS

THE PRESENT SITUATION

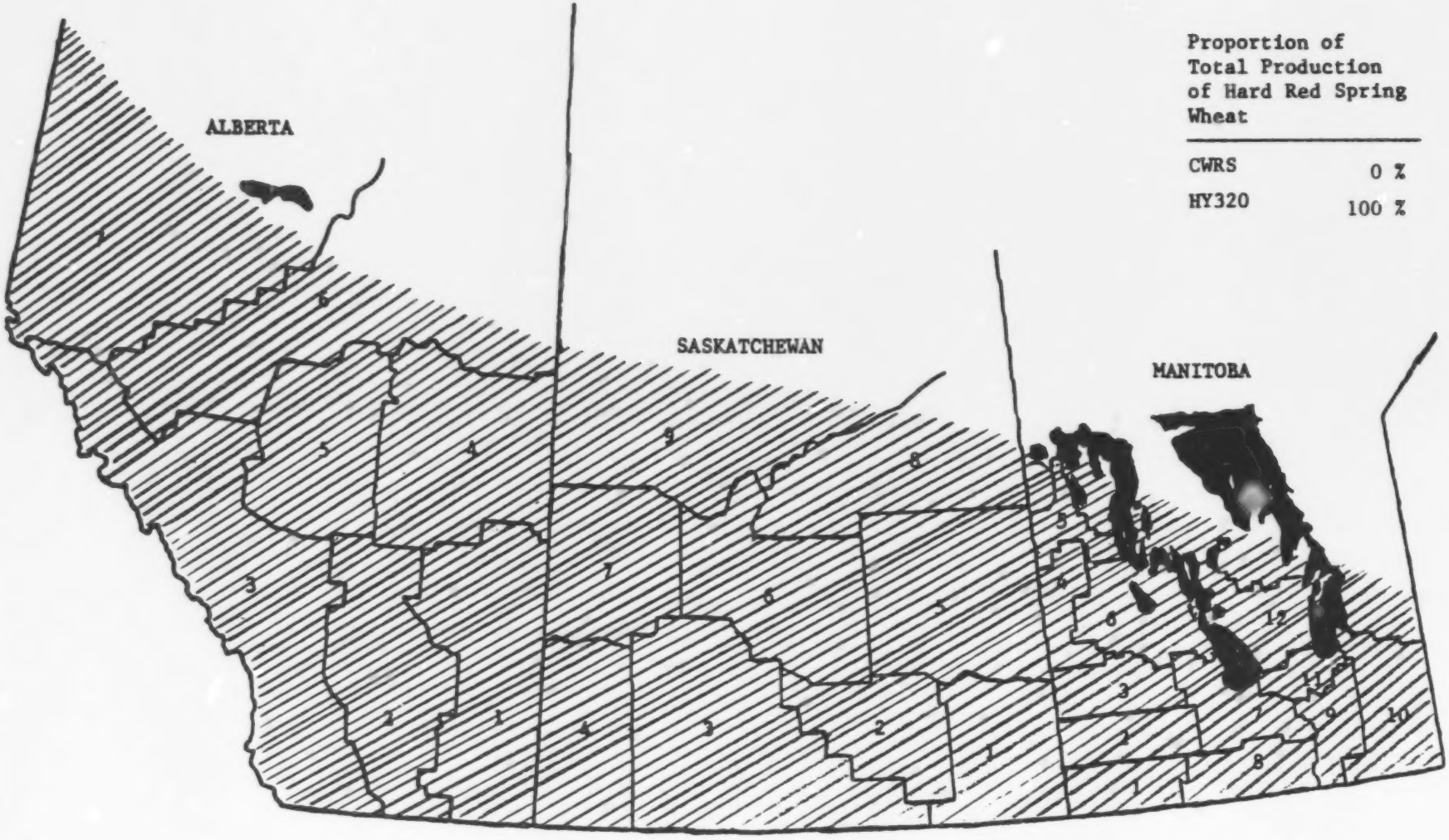
Map of the Praires showing Crop District Boundaries




| Proportion of Total Production of Hard Red Spring Wheat | |
|---|---|
| CWRS | 100 % |
| HY320 | 0 % |

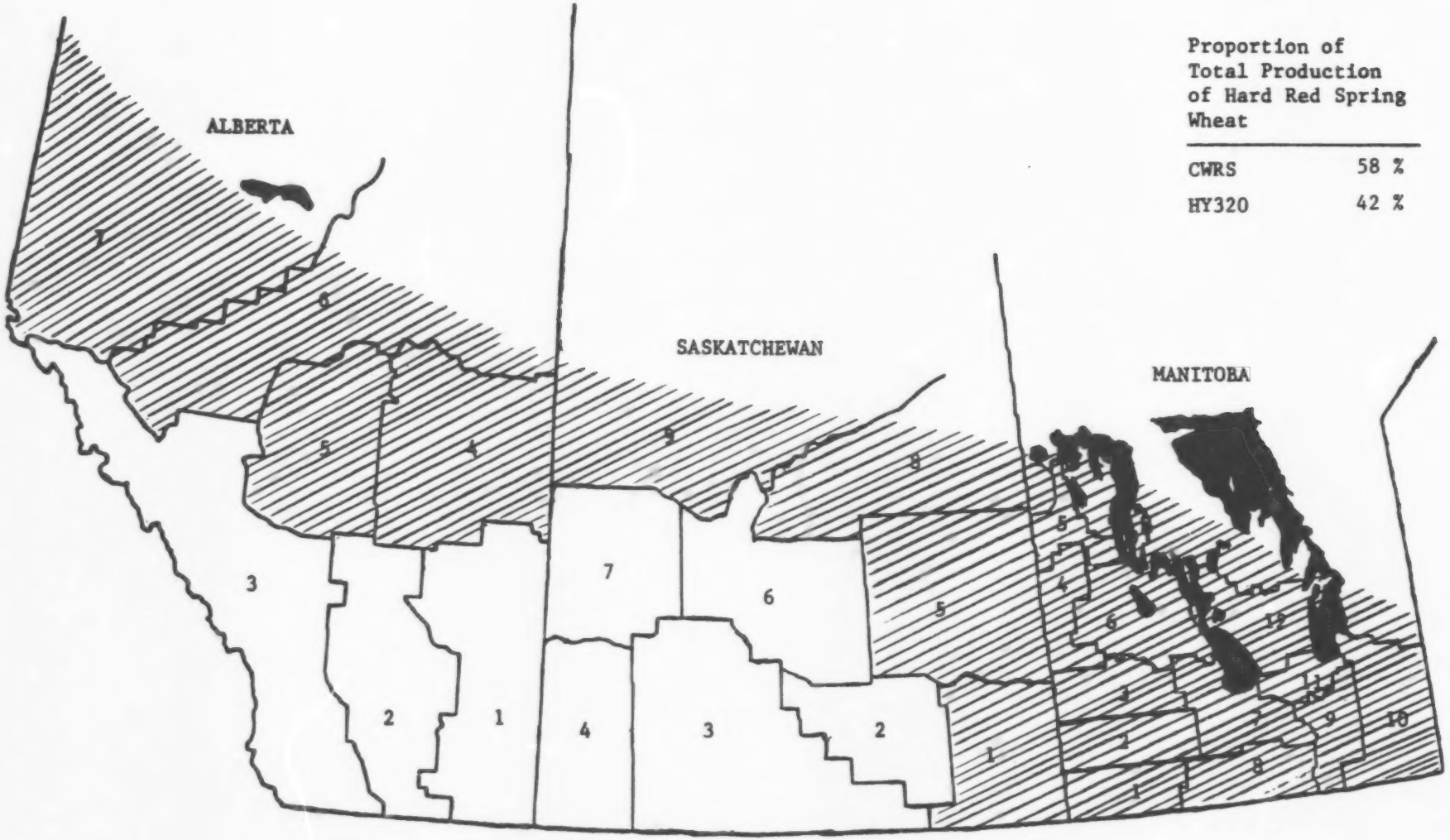
CROP DISTRICTS THAT WOULD GAIN BY GROWING HY320 INSTEAD OF TRADITIONAL CWRS VARIETIES

if: 1)"weighted" HY price



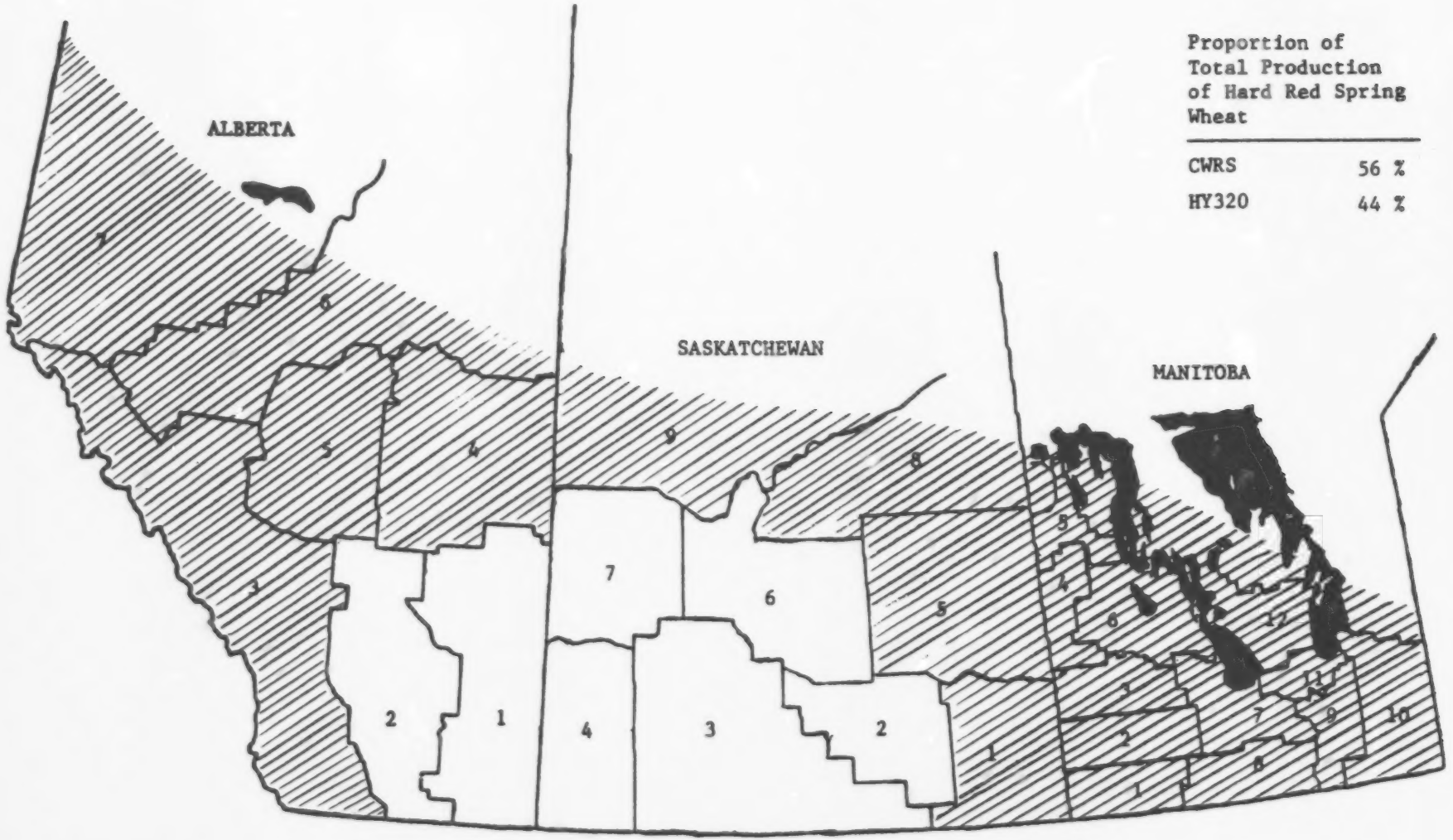
CROP DISTRICTS THAT WOULD GAIN BY GROWING HY320 INSTEAD OF TRADITIONAL CWRS VARIETIES

if: i)HY price = FEED CWRS price



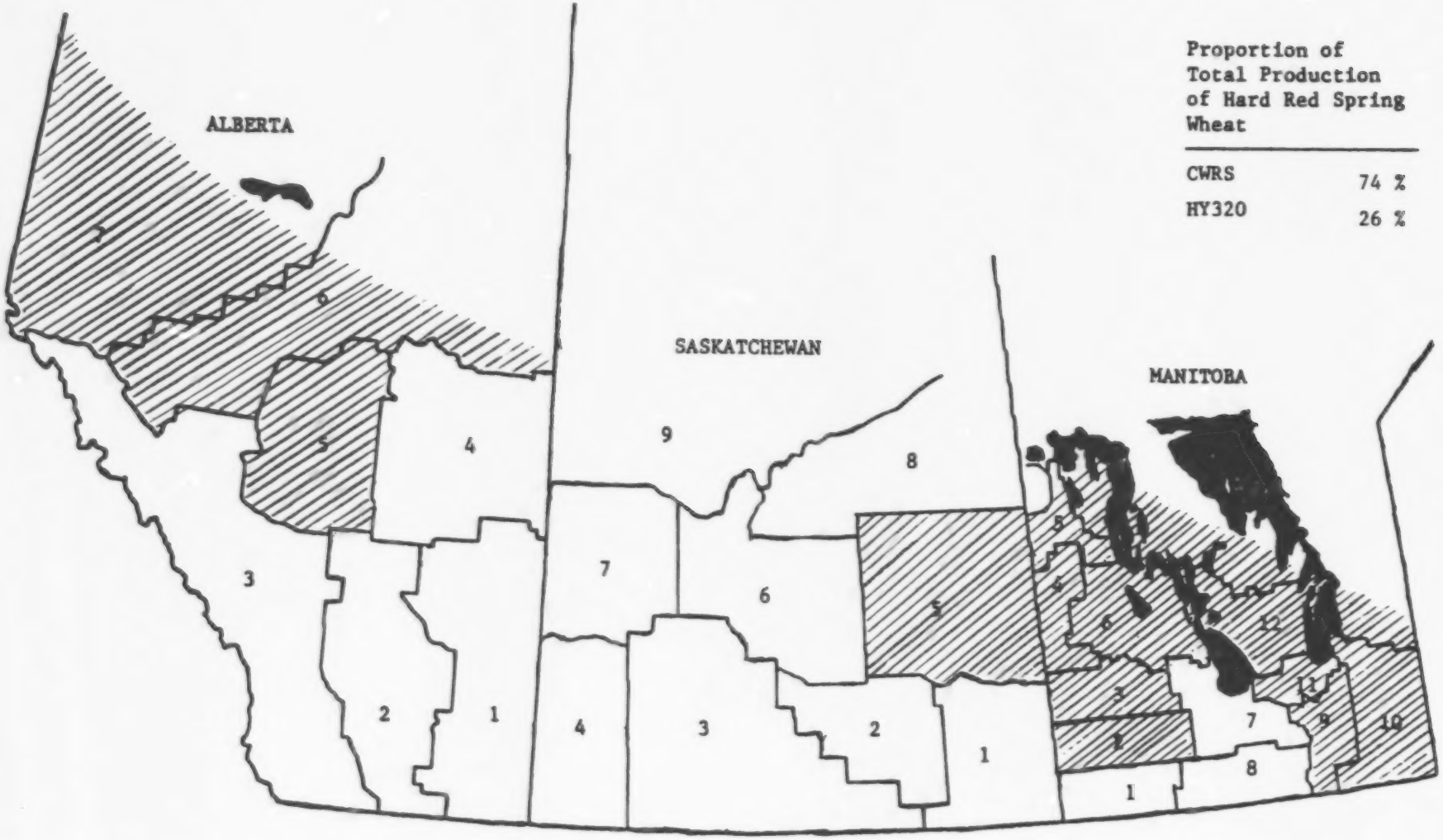
CROP DISTRICTS THAT WOULD GAIN BY GROWING HY320 INSTEAD OF TRADITIONAL CWRS VARIETIES

if: 1) "weighted" HY price
2) relative price of #1 and #2 CWRS raised 10 %



CROP DISTRICTS THAT WOULD GAIN BY GROWING HY320 INSTEAD OF TRADITIONAL CWRS VARIETIES

if: 1) "weighted" HY price
2) relative price of #1 and #2 CWRS raised 20 %




| Proportion of Total Production of Hard Red Spring Wheat | |
|---|---|
| CWRS | 74 % |
| HY320 | 26 % |

## SASKATCHEWAN CROP DISTRICTS ANNUAL CWRS GRADE BREAKDOWN

### Crop District # 1

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| 72-73 | 0.48 | 0.36 | 0.15 | 0.02 | |
| 73-74 | 0.38 | 0.27 | 0.32 | 0.02 | |
| 74-75 | 0.09 | 0.19 | 0.34 | 0.37 | |
| 75-76 | 0.08 | 0.59 | 0.30 | 0.03 | |
| 76-77 | 0.69 | 0.28 | 0.03 | 0.00 | |
| 77-78 | 0.48 | 0.16 | 0.33 | 0.03 | |
| 78-79 | 0.54 | 0.32 | 0.14 | 0.00 | |
| 79-80 | 0.19 | 0.30 | 0.32 | 0.20 | |
| 80-81 | 0.06 | 0.47 | 0.43 | 0.04 | |
| 81-82 | 0.21 | 0.43 | 0.33 | 0.02 | |
| 82-83 | 0.30 | 0.31 | 0.26 | 0.13 | |

### Crop District # 2

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| 72-73 | 0.77 | 0.16 | 0.06 | 0.02 | |
| 73-74 | 0.41 | 0.39 | 0.18 | 0.02 | |
| 74-75 | 0.07 | 0.10 | 0.24 | 0.59 | |
| 75-76 | 0.11 | 0.58 | 0.29 | 0.02 | |
| 76-77 | 0.86 | 0.12 | 0.02 | 0.00 | |
| 77-78 | 0.61 | 0.13 | 0.23 | 0.03 | |
| 78-79 | 0.64 | 0.22 | 0.13 | 0.01 | |
| 79-80 | 0.49 | 0.20 | 0.19 | 0.11 | |
| 80-81 | 0.30 | 0.47 | 0.21 | 0.02 | |
| 81-82 | 0.43 | 0.44 | 0.12 | 0.00 | |
| 82-83 | 0.59 | 0.20 | 0.15 | 0.05 | |

### Crop District # 3

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| 72-73 | 0.89 | 0.09 | 0.02 | 0.01 | |
| 73-74 | 0.69 | 0.26 | 0.04 | 0.01 | |
| 74-75 | 0.28 | 0.16 | 0.26 | 0.31 | |
| 75-76 | 0.37 | 0.42 | 0.16 | 0.05 | |
| 76-77 | 0.94 | 0.05 | 0.01 | 0.00 | |
| 77-78 | 0.85 | 0.11 | 0.04 | 0.01 | |
| 78-79 | 0.68 | 0.19 | 0.10 | 0.03 | |
| 79-80 | 0.87 | 0.09 | 0.03 | 0.01 | |
| 80-81 | 0.74 | 0.20 | 0.06 | 0.01 | |
| 81-82 | 0.93 | 0.07 | 0.01 | 0.00 | |
| 82-83 | 0.82 | 0.11 | 0.06 | 0.01 | |

### Crop District # 4

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| 72-73 | 0.75 | 0.19 | 0.06 | 0.01 | |
| 73-74 | 0.87 | 0.10 | 0.01 | 0.01 | |
| 74-75 | 0.56 | 0.12 | 0.17 | 0.16 | |
| 75-76 | 0.49 | 0.27 | 0.15 | 0.08 | |
| 76-77 | 0.90 | 0.07 | 0.02 | 0.01 | |
| 77-78 | 0.82 | 0.15 | 0.03 | 0.01 | |
| 78-79 | 0.57 | 0.25 | 0.16 | 0.02 | |
| 79-80 | 0.91 | 0.08 | 0.01 | 0.00 | |
| 80-81 | 0.83 | 0.11 | 0.05 | 0.01 | |
| 81-82 | 0.97 | 0.03 | 0.00 | 0.00 | |
| 82-83 | 0.91 | 0.06 | 0.02 | 0.01 | |

### Crop District # 5

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| 72-73 | 0.38 | 0.30 | 0.24 | 0.07 | |
| 73-74 | 0.19 | 0.46 | 0.32 | 0.03 | |
| 74-75 | 0.03 | 0.13 | 0.31 | 0.52 | |
| 75-76 | 0.02 | 0.45 | 0.47 | 0.06 | |
| 76-77 | 0.33 | 0.57 | 0.10 | 0.00 | |
| 77-78 | 0.17 | 0.10 | 0.43 | 0.30 | |
| 78-79 | 0.18 | 0.25 | 0.37 | 0.21 | |
| 79-80 | 0.10 | 0.19 | 0.46 | 0.25 | |
| 80-81 | 0.03 | 0.30 | 0.57 | 0.11 | |
| 81-82 | 0.30 | 0.64 | 0.06 | 0.00 | |
| 82-83 | 0.10 | 0.10 | 0.35 | 0.45 | |

### Crop District # 6

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| 72-73 | 0.79 | 0.14 | 0.06 | 0.01 | |
| 73-74 | 0.47 | 0.41 | 0.11 | 0.01 | |
| 74-75 | 0.11 | 0.18 | 0.34 | 0.37 | |
| 75-76 | 0.28 | 0.53 | 0.15 | 0.04 | |
| 76-77 | 0.82 | 0.13 | 0.04 | 0.01 | |
| 77-78 | 0.54 | 0.17 | 0.24 | 0.04 | |
| 78-79 | 0.47 | 0.22 | 0.29 | 0.03 | |
| 79-80 | 0.68 | 0.15 | 0.14 | 0.03 | |
| 80-81 | 0.41 | 0.40 | 0.15 | 0.03 | |
| 81-82 | 0.73 | 0.25 | 0.02 | 0.00 | |
| 82-83 | 0.35 | 0.20 | 0.28 | 0.18 | |

### Crop District # 7

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| 72-73 | 0.72 | 0.17 | 0.09 | 0.02 | |
| 73-74 | 0.77 | 0.18 | 0.04 | 0.01 | |
| 74-75 | 0.09 | 0.14 | 0.23 | 0.55 | |
| 75-76 | 0.06 | 0.25 | 0.38 | 0.30 | |
| 76-77 | 0.89 | 0.08 | 0.02 | 0.00 | |
| 77-78 | 0.46 | 0.21 | 0.23 | 0.10 | |
| 78-79 | 0.48 | 0.24 | 0.22 | 0.06 | |
| 79-80 | 0.75 | 0.16 | 0.08 | 0.01 | |
| 80-81 | 0.27 | 0.29 | 0.33 | 0.11 | |
| 81-82 | 0.87 | 0.09 | 0.04 | 0.00 | |
| 82-83 | 0.51 | 0.36 | 0.09 | 0.04 | |

### Crop District # 8

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| 72-73 | 0.31 | 0.26 | 0.36 | 0.07 | |
| 73-74 | 0.21 | 0.39 | 0.36 | 0.04 | |
| 74-75 | 0.02 | 0.15 | 0.44 | 0.39 | |
| 75-76 | 0.05 | 0.48 | 0.43 | 0.04 | |
| 76-77 | 0.45 | 0.49 | 0.06 | 0.00 | |
| 77-78 | 0.17 | 0.10 | 0.47 | 0.26 | |
| 78-79 | 0.08 | 0.13 | 0.60 | 0.19 | |
| 79-80 | 0.11 | 0.30 | 0.36 | 0.24 | |
| 80-81 | 0.02 | 0.37 | 0.56 | 0.05 | |
| 81-82 | 0.45 | 0.39 | 0.16 | 0.00 | |
| 82-83 | 0.03 | 0.07 | 0.28 | 0.62 | |

### Crop District # 9

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| 72-73 | 0.23 | 0.31 | 0.40 | 0.06 | |
| 73-74 | 0.22 | 0.37 | 0.37 | 0.04 | |
| 74-75 | 0.06 | 0.16 | 0.35 | 0.43 | |
| 75-76 | 0.10 | 0.39 | 0.36 | 0.15 | |
| 76-77 | 0.44 | 0.41 | 0.15 | 0.00 | |
| 77-78 | 0.13 | 0.09 | 0.39 | 0.39 | |
| 78-79 | 0.16 | 0.19 | 0.33 | 0.12 | |
| 79-80 | 0.26 | 0.37 | 0.29 | 0.08 | |
| 80-81 | 0.03 | 0.23 | 0.58 | 0.16 | |
| 81-82 | 0.45 | 0.44 | 0.10 | 0.01 | |
| 82-83 | 0.03 | 0.22 | 0.39 | 0.37 | |

## ALBERTA CROP DISTRICTS ANNUAL CWRS GRADE BREAKDOWN

Crop District # 1

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| 72-73 | 0.78 | 0.17 | 0.05 | 0.00 |
| 73-74 | 0.69 | 0.27 | 0.04 | 0.00 |
| 74-75 | 0.50 | 0.27 | 0.15 | 0.08 |
| 75-76 | 0.54 | 0.27 | 0.14 | 0.05 |
| 76-77 | 0.85 | 0.13 | 0.01 | 0.00 |
| 77-78 | 0.61 | 0.20 | 0.16 | 0.03 |
| 78-79 | 0.50 | 0.26 | 0.17 | 0.07 |
| 79-80 | 0.86 | 0.10 | 0.03 | 0.01 |
| 80-81 | 0.69 | 0.18 | 0.11 | 0.02 |
| 81-82 | 0.93 | 0.04 | 0.01 | 0.00 |
| 82-83 | 0.70 | 0.21 | 0.07 | 0.02 |

Crop District # 2

| | | | | |
|---|---|---|---|---|
| 72-73 | 0.45 | 0.38 | 0.16 | 0.01 |
| 73-74 | 0.43 | 0.45 | 0.10 | 0.02 |
| 74-75 | 0.30 | 0.24 | 0.26 | 0.20 |
| 75-76 | 0.35 | 0.34 | 0.24 | 0.08 |
| 76-77 | 0.75 | 0.21 | 0.03 | 0.01 |
| 77-78 | 0.40 | 0.25 | 0.31 | 0.05 |
| 78-79 | 0.25 | 0.37 | 0.30 | 0.08 |
| 79-80 | 0.77 | 0.18 | 0.05 | 0.00 |
| 80-81 | 0.36 | 0.28 | 0.27 | 0.09 |
| 81-82 | 0.76 | 0.17 | 0.07 | 0.01 |
| 82-83 | 0.46 | 0.30 | 0.17 | 0.07 |

Crop District # 3

| | | | | |
|---|---|---|---|---|
| 72-73 | 0.18 | 0.48 | 0.30 | 0.04 |
| 73-74 | 0.26 | 0.56 | 0.17 | 0.01 |
| 74-75 | 0.18 | 0.24 | 0.30 | 0.28 |
| 75-76 | 0.25 | 0.38 | 0.29 | 0.08 |
| 76-77 | 0.60 | 0.32 | 0.08 | 0.01 |
| 77-78 | 0.32 | 0.27 | 0.31 | 0.09 |
| 78-79 | 0.16 | 0.41 | 0.35 | 0.08 |
| 79-80 | 0.61 | 0.32 | 0.07 | 0.00 |
| 80-81 | 0.23 | 0.29 | 0.24 | 0.24 |
| 81-82 | 0.50 | 0.32 | 0.17 | 0.02 |
| 82-83 | 0.44 | 0.33 | 0.18 | 0.05 |

Crop District # 4

| | | | | |
|---|---|---|---|---|
| 72-73 | 0.11 | 0.26 | 0.56 | 0.07 |
| 73-74 | 0.13 | 0.41 | 0.39 | 0.07 |
| 74-75 | 0.01 | 0.08 | 0.27 | 0.64 |
| 75-76 | 0.02 | 0.28 | 0.48 | 0.23 |
| 76-77 | 0.23 | 0.59 | 0.17 | 0.01 |
| 77-78 | 0.08 | 0.11 | 0.48 | 0.33 |
| 78-79 | 0.03 | 0.05 | 0.50 | 0.41 |
| 79-80 | 0.14 | 0.51 | 0.29 | 0.06 |
| 80-81 | 0.02 | 0.11 | 0.59 | 0.27 |
| 81-82 | 0.40 | 0.47 | 0.11 | 0.02 |
| 82-83 | 0.06 | 0.35 | 0.40 | 0.19 |

Crop District # 5

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| 72-73 | 0.03 | 0.22 | 0.65 | 0.11 |
| 73-74 | 0.01 | 0.11 | 0.68 | 0.20 |
| 74-75 | 0.00 | 0.01 | 0.25 | 0.74 |
| 75-76 | 0.00 | 0.17 | 0.56 | 0.27 |
| 76-77 | 0.03 | 0.33 | 0.58 | 0.05 |
| 77-78 | 0.01 | 0.04 | 0.64 | 0.32 |
| 78-79 | 0.01 | 0.02 | 0.34 | 0.63 |
| 79-80 | 0.05 | 0.45 | 0.44 | 0.06 |
| 80-81 | 0.01 | 0.02 | 0.36 | 0.61 |
| 81-82 | 0.09 | 0.58 | 0.31 | 0.02 |
| 82-83 | 0.01 | 0.05 | 0.47 | 0.47 |

Crop District # 6

| | | | | |
|---|---|---|---|---|
| 72-73 | 0.00 | 0.10 | 0.70 | 0.20 |
| 73-74 | 0.00 | 0.07 | 0.61 | 0.32 |
| 74-75 | 0.00 | 0.00 | 0.14 | 0.86 |
| 75-76 | 0.01 | 0.13 | 0.71 | 0.15 |
| 76-77 | 0.00 | 0.13 | 0.82 | 0.05 |
| 77-78 | 0.00 | 0.02 | 0.20 | 0.78 |
| 78-79 | 0.01 | 0.03 | 0.35 | 0.61 |
| 79-80 | 0.00 | 0.28 | 0.50 | 0.21 |
| 80-81 | 0.00 | 0.01 | 0.26 | 0.73 |
| 81-82 | 0.05 | 0.46 | 0.47 | 0.02 |
| 82-83 | 0.00 | 0.03 | 0.22 | 0.75 |

Crop District # 7

| | | | | |
|---|---|---|---|---|
| 72-73 | 0.00 | 0.10 | 0.73 | 0.17 |
| 73-74 | 0.00 | 0.05 | 0.43 | 0.52 |
| 74-75 | 0.00 | 0.04 | 0.30 | 0.66 |
| 75-76 | 0.01 | 0.21 | 0.62 | 0.17 |
| 76-77 | 0.00 | 0.19 | 0.75 | 0.06 |
| 77-78 | 0.00 | 0.07 | 0.48 | 0.46 |
| 78-79 | 0.00 | 0.03 | 0.35 | 0.63 |
| 79-80 | 0.01 | 0.33 | 0.55 | 0.12 |
| 80-81 | 0.00 | 0.06 | 0.48 | 0.46 |
| 81-82 | 0.43 | 0.36 | 0.20 | 0.01 |
| 82-83 | 0.02 | 0.06 | 0.55 | 0.37 |

## MANITOBA CROP DISTRICTS ANNUAL CWRS GRADE BREAKDOWN

Crop District # 1

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| 72-73 | 0.43 | 0.47 | 0.10 | 0.00 | |
| 73-74 | 0.26 | 0.49 | 0.25 | 0.00 | |
| 74-75 | 0.27 | 0.46 | 0.18 | 0.09 | |
| 75-76 | 0.18 | 0.51 | 0.29 | 0.03 | |
| 76-77 | 0.50 | 0.48 | 0.02 | 0.00 | |
| 77-78 | 0.39 | 0.23 | 0.15 | 0.03 | |
| 78-79 | 0.47 | 0.39 | 0.14 | 0.01 | |
| 79-80 | 0.31 | 0.34 | 0.29 | 0.06 | |
| 80-81 | 0.01 | 0.08 | 0.77 | 0.14 | |
| 81-82 | 0.16 | 0.45 | 0.37 | 0.01 | |
| 82-83 | 0.20 | 0.24 | 0.29 | 0.26 | |

Crop District # 5

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| 72-73 | 0.05 | 0.22 | 0.38 | 0.35 | |
| 73-74 | 0.07 | 0.35 | 0.56 | 0.02 | |
| 74-75 | 0.00 | 0.04 | 0.49 | 0.47 | |
| 75-76 | 0.00 | 0.11 | 0.69 | 0.19 | |
| 76-77 | 0.07 | 0.58 | 0.35 | 0.01 | |
| 77-78 | 0.04 | 0.11 | 0.16 | 0.69 | |
| 78-79 | 0.05 | 0.16 | 0.38 | 0.40 | |
| 79-80 | 0.04 | 0.52 | 0.30 | 0.14 | |
| 80-81 | 0.00 | 0.15 | 0.74 | 0.11 | |
| 81-82 | 0.15 | 0.68 | 0.16 | 0.00 | |
| 82-83 | 0.05 | 0.18 | 0.40 | 0.38 | |

Crop District # 9

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| 72-73 | 0.15 | 0.54 | 0.31 | 0.00 | |
| 73-74 | 0.15 | 0.51 | 0.34 | 0.00 | |
| 74-75 | 0.05 | 0.39 | 0.40 | 0.16 | |
| 75-76 | 0.06 | 0.55 | 0.35 | 0.03 | |
| 76-77 | 0.38 | 0.56 | 0.06 | 0.00 | |
| 77-78 | 0.13 | 0.22 | 0.34 | 0.30 | |
| 78-79 | 0.28 | 0.50 | 0.17 | 0.05 | |
| 79-80 | 0.09 | 0.64 | 0.23 | 0.03 | |
| 80-81 | 0.00 | 0.17 | 0.77 | 0.06 | |
| 81-82 | 0.33 | 0.57 | 0.10 | 0.00 | |
| 82-83 | 0.09 | 0.38 | 0.35 | 0.18 | |

Crop District # 2

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| 72-73 | 0.29 | 0.52 | 0.18 | 0.02 | |
| 73-74 | 0.19 | 0.51 | 0.29 | 0.01 | |
| 74-75 | 0.19 | 0.48 | 0.24 | 0.09 | |
| 75-76 | 0.04 | 0.49 | 0.40 | 0.07 | |
| 76-77 | 0.39 | 0.59 | 0.02 | 0.00 | |
| 77-78 | 0.38 | 0.20 | 0.33 | 0.09 | |
| 78-79 | 0.28 | 0.48 | 0.22 | 0.02 | |
| 79-80 | 0.33 | 0.49 | 0.15 | 0.02 | |
| 80-81 | 0.01 | 0.13 | 0.76 | 0.10 | |
| 81-82 | 0.16 | 0.24 | 0.59 | 0.00 | |
| 82-83 | 0.19 | 0.22 | 0.27 | 0.31 | |

Crop District # 6

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| 72-73 | 0.17 | 0.59 | 0.19 | 0.05 | |
| 73-74 | 0.04 | 0.27 | 0.67 | 0.02 | |
| 74-75 | 0.00 | 0.26 | 0.68 | 0.06 | |
| 75-76 | 0.00 | 0.15 | 0.77 | 0.08 | |
| 76-77 | 0.25 | 0.59 | 0.15 | 0.00 | |
| 77-78 | 0.04 | 0.11 | 0.35 | 0.50 | |
| 78-79 | 0.04 | 0.14 | 0.48 | 0.35 | |
| 79-80 | 0.07 | 0.40 | 0.44 | 0.09 | |
| 80-81 | 0.01 | 0.13 | 0.78 | 0.08 | |
| 81-82 | 0.04 | 0.42 | 0.54 | 0.01 | |
| 82-83 | 0.07 | 0.52 | 0.31 | 0.10 | |

Crop District # 10

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| 72-73 | 0.03 | 0.49 | 0.40 | 0.07 | |
| 73-74 | 0.01 | 0.21 | 0.71 | 0.07 | |
| 74-75 | 0.00 | 0.07 | 0.38 | 0.55 | |
| 75-76 | 0.00 | 0.15 | 0.75 | 0.10 | |
| 76-77 | 0.20 | 0.58 | 0.23 | 0.00 | |
| 77-78 | 0.01 | 0.16 | 0.36 | 0.47 | |
| 78-79 | 0.00 | 0.65 | 0.30 | 0.05 | |
| 79-80 | 0.01 | 0.67 | 0.24 | 0.09 | |
| 80-81 | 0.00 | 0.00 | 0.80 | 0.20 | |
| 81-82 | 0.00 | 0.35 | 0.63 | 0.03 | |
| 82-83 | 0.00 | 0.20 | 0.40 | 0.40 | |

Crop District # 3

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| 72-73 | 0.22 | 0.51 | 0.25 | 0.02 | |
| 73-74 | 0.11 | 0.51 | 0.37 | 0.00 | |
| 74-75 | 0.07 | 0.30 | 0.37 | 0.26 | |
| 75-76 | 0.00 | 0.34 | 0.59 | 0.06 | |
| 76-77 | 0.34 | 0.63 | 0.03 | 0.00 | |
| 77-78 | 0.17 | 0.18 | 0.50 | 0.15 | |
| 78-79 | 0.24 | 0.44 | 0.28 | 0.04 | |
| 79-80 | 0.15 | 0.49 | 0.28 | 0.09 | |
| 80-81 | 0.00 | 0.06 | 0.82 | 0.12 | |
| 81-82 | 0.09 | 0.37 | 0.54 | 0.00 | |
| 82-83 | 0.15 | 0.25 | 0.29 | 0.31 | |

Crop District # 7

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| 72-73 | 0.28 | 0.59 | 0.13 | 0.00 | |
| 73-74 | 0.08 | 0.60 | 0.31 | 0.00 | |
| 74-75 | 0.06 | 0.53 | 0.29 | 0.13 | |
| 75-76 | 0.02 | 0.57 | 0.36 | 0.06 | |
| 76-77 | 0.48 | 0.46 | 0.06 | 0.00 | |
| 77-78 | 0.14 | 0.26 | 0.38 | 0.23 | |
| 78-79 | 0.12 | 0.54 | 0.30 | 0.04 | |
| 79-80 | 0.20 | 0.62 | 0.16 | 0.02 | |
| 80-81 | 0.00 | 0.14 | 0.77 | 0.09 | |
| 81-82 | 0.27 | 0.53 | 0.20 | 0.00 | |
| 82-83 | 0.13 | 0.54 | 0.24 | 0.09 | |

Crop District # 11

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| 72-73 | 0.20 | 0.49 | 0.30 | 0.02 | |
| 73-74 | 0.08 | 0.50 | 0.41 | 0.02 | |
| 74-75 | 0.00 | 0.45 | 0.37 | 0.18 | |
| 75-76 | 0.01 | 0.50 | 0.44 | 0.05 | |
| 76-77 | 0.39 | 0.55 | 0.06 | 0.00 | |
| 77-78 | 0.13 | 0.16 | 0.40 | 0.32 | |
| 78-79 | 0.15 | 0.52 | 0.27 | 0.06 | |
| 79-80 | 0.08 | 0.55 | 0.30 | 0.07 | |
| 80-81 | 0.00 | 0.18 | 0.74 | 0.08 | |
| 81-82 | 0.24 | 0.62 | 0.13 | 0.01 | |
| 82-83 | 0.03 | 0.35 | 0.46 | 0.15 | |

Crop District # 4

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| 72-73 | 0.10 | 0.35 | 0.41 | 0.14 | |
| 73-74 | 0.07 | 0.26 | 0.66 | 0.01 | |
| 74-75 | 0.00 | 0.12 | 0.35 | 0.52 | |
| 75-76 | 0.00 | 0.10 | 0.81 | 0.08 | |
| 76-77 | 0.09 | 0.81 | 0.09 | 0.00 | |
| 77-78 | 0.05 | 0.10 | 0.46 | 0.38 | |
| 78-79 | 0.11 | 0.28 | 0.35 | 0.26 | |
| 79-80 | 0.05 | 0.30 | 0.40 | 0.26 | |
| 80-81 | 0.00 | 0.11 | 0.74 | 0.15 | |
| 81-82 | 0.09 | 0.62 | 0.29 | 0.00 | |
| 82-83 | 0.14 | 0.32 | 0.28 | 0.26 | |

Crop District # 8

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| 72-73 | 0.23 | 0.58 | 0.19 | 0.00 | |
| 73-74 | 0.11 | 0.60 | 0.29 | 0.00 | |
| 74-75 | 0.15 | 0.56 | 0.22 | 0.08 | |
| 75-76 | 0.16 | 0.69 | 0.14 | 0.02 | |
| 76-77 | 0.35 | 0.61 | 0.04 | 0.00 | |
| 77-78 | 0.26 | 0.36 | 0.24 | 0.14 | |
| 78-79 | 0.18 | 0.65 | 0.16 | 0.01 | |
| 79-80 | 0.23 | 0.64 | 0.11 | 0.02 | |
| 80-81 | 0.01 | 0.14 | 0.69 | 0.16 | |
| 81-82 | 0.23 | 0.51 | 0.26 | 0.00 | |
| 82-83 | 0.22 | 0.43 | 0.21 | 0.15 | |

Crop District # 12

| | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| 72-73 | 0.11 | 0.71 | 0.16 | 0.02 | |
| 73-74 | 0.05 | 0.41 | 0.53 | 0.01 | |
| 74-75 | 0.00 | 0.14 | 0.57 | 0.29 | |
| 75-76 | 0.00 | 0.19 | 0.67 | 0.14 | |
| 76-77 | 0.16 | 0.73 | 0.11 | 0.00 | |
| 77-78 | 0.02 | 0.12 | 0.72 | 0.15 | |
| 78-79 | 0.02 | 0.33 | 0.46 | 0.18 | |
| 79-80 | 0.00 | 0.31 | 0.53 | 0.15 | |
| 80-81 | 0.01 | 0.14 | 0.68 | 0.18 | |
| 81-82 | 0.03 | 0.51 | 0.40 | 0.05 | |
| 82-83 | 0.02 | 0.11 | 0.16 | 0.72 | |